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The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

The Evolution of the Heavy Oil Engine.

Motor Car Works at Lincoln (With a Two-Page Supplement).

Wagon Stock on British Railways.

Precision Measuring Instrument for Small Motions.

The Air Conference.

A New Closed Feed System.

Creosote Treatment of Sleepers.

PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—
WHEELS AND AXLES FOR RAILWAY CARRIAGES.
Forms of Tender may be obtained from the Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Tuesday, the 6th March, 1923.
T. RYAN,
Director-General.
1462

Borough of Folkestone.
SEA OUTFALL.
The Corporation is prepared to receive TENDERS for the CONSTRUCTION of about 750 YARDS LINEAL of 48in. diam. and 330 YARDS of 36in. diam. IRON PIPE SEA OUTFALL SEWERS on the foreshore, and about 200 YARDS LINEAL of 15in. IRON PIPE, and 280 YARDS LINEAL of 12in. STONEWARE PIPE COLLECTING SEWERS, together with MANHOLES, &c., and all appurtenant Works.
The plans may be seen and quantities and form of Tender obtained at the office of the Engineers, Messrs. W. H. Radford and Son, Albion Chambers, King-street, Nottingham, on deposit of Three Guineas (cheque), which will be returned on receipt of a bona fide Tender and the return of the quantities.
A copy of the plans may also be seen at the office of the Borough Engineer, A. E. Nichols, Esq., M.I.C.E., Borough Engineer's Office, Folkestone.
In case of firms employing more than 20 men preference will be given to those whose names are on the King's Roll of Honour.
The lowest or any Tender will not necessarily be accepted.
Sealed Tenders to be delivered or sent to the undersigned on or before Thursday, February 22nd, 1923, endorsed "Outfall Sewer."
By Order,
A. F. KIDSON,
Town Clerk.
Town Clerk's Office,
Folkestone, Kent,
3rd February, 1923. 1455

Borough of Portsmouth.
EIGHT-TON ELECTRIC CRANE.
The Portsmouth Town Council invite DESIGNS and TENDERS for the CONSTRUCTION and MAINTENANCE in thorough repair for 12 calendar months from the completion thereof of the following WORKS, that is to say :—
An ELECTRICALLY OPERATED PORTABLE JIB CRANE at the Quay, near the entrance to Graving Dock, to lift 8 tons at 30ft. radius and 1½ tons at 50ft. radius.
Copies of drawings, the conditions of tendering, and the general conditions under which the Designs and Tenders are invited can be obtained on application (accompanied by the sum of £2 2s., which will be refunded on the return of the documents within three days or on the receipt of a bona fide Tender, accompanied by the documents required) to Mr. Arthur W. Ward, Borough Engineer, Town Hall, Portsmouth, from whom any further particulars can be obtained.
The work will have to be carried out under the trade union rules in force in the borough.
Tenders, marked "Tender for Crane, Outer Camber," are to be sent in on the form supplied, accompanied by the drawings, &c., issued by the Corporation, together with the tenderer's design and specification, as required in the conditions of tendering, and must reach the undersigned not later than 10 a.m. on Tuesday, 6th March, 1923.
The Council do not bind themselves to accept the lowest or any Tender.
F. J. SPARKS,
Town Clerk.
The Town Hall, Portsmouth,
6th February, 1923. 1466

Chesterfield Corporation.
WATER DEPARTMENT.
TO BORE-HOLE SINKERS.
The above Corporation is prepared to receive TENDERS for the SINKING of a BORE-HOLE near Chesterfield.
Specifications may be obtained upon application to the above Department, West Bars, Chesterfield.
Tenders to be addressed to the Engineer and Manager, Corporation Water Department, West Bars, Chesterfield.
CHAS. BOLDRY,
1488 Engineer and Manager.

TENDERS INVITED.
County of London Electric
SUPPLY CO., LTD.
BARKING POWER STATION.
The County of London Electric Supply Company, Limited, are open to receive TENDERS for the SUPPLY and ERECTION of CONDENSING PLANT and AUXILIARY APPARATUS for their Barking Power Station. Specifications may be obtained by manufacturers from the offices of the Company on application to the undersigned on or after February, 12th, 1923, and on payment of a fee of Five Guineas for the first copy and Two Guineas for every subsequent copy. Sealed Tenders, marked "Tenders for Condensing Plant and Auxiliary Apparatus for Barking Power Station," are to be addressed to the Chairman and Managing Director and lodged at the Registered Office of the Company by Noon on March 12th, 1923. Sums paid for any number of copies up to three will be refunded on receipt of a bona fide Tender. The Company do not bind themselves to accept the lowest or any Tender.
F. C. McQUOWN,
Manager and Secretary,
The County of London Electric Supply Co., Ltd.,
1475 Moorgate-court, Moorgate-place, E.C. 2.

TENDERS INVITED.
County of London Electric
SUPPLY CO., LTD.
BARKING POWER STATION.
The County of London Electric Supply Company, Limited, are open to receive TENDERS for the SUPPLY and ERECTION of STATIC TRANSFORMERS for their Barking Power Station. Specifications may be obtained by manufacturers from the offices of the Company on application to the undersigned on or after February 12th, 1923, and on payment of a fee of Five Guineas for the first copy and Two Guineas for every subsequent copy. Sealed Tenders marked "Tenders for Static Transformers for Barking Power Station," are to be addressed to the Chairman and Managing Director and lodged at the Registered Office of the Company by Noon on March 26th, 1923. Sums paid for any number of copies up to three will be refunded on receipt of a bona fide Tender. The Company do not bind themselves to accept the lowest or any Tender.
F. C. McQUOWN,
Manager and Secretary,
County of London Electric Supply Co., Ltd.,
1470 Moorgate-court, Moorgate-place, E.C.

PUBLIC NOTICES

County Borough of St. Helens.
The Corporation of St. Helens are prepared to receive TENDERS for the LAYING of about 7495 LIN. YDS. of TRAMWAY PERMANENT WAY from the Borough Boundary, Eccleston Hill, to Higher Parr-street, St. Helens.
Drawings and conditions of contract may be seen and specification, form of Tender, and bill of quantities obtained on application to Mr. Arthur W. Bradley, M. Inst. C.E., Borough and Water Engineer, on payment of £2, which will be returned on receipt of a bona fide Tender.
Sealed Tenders to be sent in on the form and in the envelope provided not later than 9 a.m. on the 28th instant.
The Corporation do not bind themselves to accept the lowest or any Tender.
W. H. ANDREW,
Town Clerk.
Town Hall, St. Helens,
February, 1923. 1456

The South Indian Railway Company, Limited, are prepared to receive TENDERS for the SUPPLY of :—
STEEL ROOFING.
Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tenders for Steel Roofing," must be left with the undersigned not later than Twelve Noon on Friday, the 2nd March, 1923.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of 2s. 6d. for each copy of the specification.
Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.
A. MUIRHEAD,
Managing Director.
91, Petty France, S.W. 1,
5th February, 1923. 1473

Municipality of George Town,
PENANG, STRAITS SETTLEMENTS.
JUNIOR ASSISTANT ENGINEER.
The Municipal Commissioners of George Town, Penang, REQUIRE an ASSISTANT to the MUNICIPAL ENGINEER, age 25 to 30, preferably unmarried, on a three years' agreement, with possible extension. Applicants must have had a good technical education and a regular training as pupil and assistant with a Borough or County Engineer or a Civil Engineer in private practice, with experience in Municipal and General Engineering Work, including Roads, Buildings, Bridges, Sewerage and Conservancy Details, and the control of workmen. It is desirable that candidates should have passed the examination of the Institution of Civil Engineers or the testamur examination of the Institution of Municipal and County Engineers.
Salary $400 dollars for the first year, rising by biennial increments of 600 dollars a year to a maximum of 9000 dollars per annum, paid monthly in dollars, the currency of the Colony, the value of the dollar being 2s. 4d. sterling. The pay of the appointment at this rate for the first year would be £680. An allowance of 1200 dollars per annum for the maintenance of a motor car will be granted. Free passage will be provided, with half-pay during the voyage out. The selected candidate must pass an approved medical examination.
Applications, stating whether married or single, age, birthplace, and giving details of education, training, and experience generally, with particular reference to the items mentioned above, and copies (only) of testimonials, to be lodged with Messrs. C. G. LINDSAY and PIERCE, MM. Inst. C.E., 180, Hope-street, Glasgow, Agents for the Commissioners (who will give further particulars if requested), not later than Tuesday, 20th February, 1923. 1469

PUBLIC NOTICES

TO TRENCH CONTRACTORS.
The Directors of the Stafford-
SHIRE POTTERIES WATERWORKS COMPANY invite TENDERS for EXCAVATING PIPE TRENCHES for and CARTING and LAYING about 4 MILES of 24in. CAST IRON PIPES.
Specification, with form of Tender and schedule of quantities, may be obtained from the undersigned on deposit of Three Guineas, which will be returned on receipt of a bona fide Tender and on return of documents sent.
Sealed Tenders, addressed to me and endorsed "Tender for Pipe Trenches," must be delivered not later than Noon, Thursday, the 1st March.
The Directors do not bind themselves to accept the lowest or any Tender.
R. C. FRAIN, M. Inst. C.E.,
Engineer.
39, Albion-street, Hanley,
Stoke-on-Trent,
9th February, 1923. 1482

SITUATIONS OPEN

WANTED, Experienced TRAVELLER, Who Wants to work as a side line to place Steam and Water Fittings (Valves, Cocks, &c.) only on a commission basis.
Address, P6873, The Engineer Office. P6873 A

WANTED IMMEDIATELY, CONTRACTORS' AGENT, capable of taking full charge large works involving tunnelling, reinforced concrete, aqueducts, in Home Counties; must be thoroughly experienced.—Reply, giving full particulars, reference, Box 247, c/o Judd's, 87, Gresham-street, E.C. 1446 A

APPLICATIONS are INVITED by Messrs. GRATON and KNIGHT, Limited, of 6, Farringdon-avenue, E.C. 4, from YOUNG MEN who have just completed their technical education in Power Transmission.—Apply by letter, stating training, age, and salary required. Successful candidates will be required to submit fullest references. 1434 A

ASSISTANT ENGINEER, with Sound Mechanical and electrical experience; competent to take complete charge (in absence of senior) of Gold Mine, tropical Africa, employing 3-phase A.C. machinery, including modern power station plant.—Address stating age, experience, with copies testimonials, 1491, The Engineer Office. 1491 A

ASSISTANT REQUIRED for Engineering Department in the East of an old-established firm. Must be under 26 years, unmarried and of good standard education, trained in office routine, estimating, contracting, &c.—Write, stating age, full particulars of education, training, and present salary, to G. L., 84, Cannon-street, London, E.C. 4. 1499 A

DAVID BROWN and SONS (Huddfd.), Ltd., Park Gear Works, Huddersfield, REQUIRE the SERVICES of a highly technical MAN with good knowledge of Gearing, to Take Charge of Advertising, Catalogues, &c. None but fully qualified men need apply. State salary and experience. 1448 A

HEATING.—Well-established London FIRM REQUIRE SERVICES of thoroughly competent and energetic MANAGER; must be capable of drawing out the most modern schemes of Heating, Domestic Supply, Drying and Ventilating. Applicants must be able to control staff of men and carry out contracts to a conclusion. Only experienced man need apply. Lucrative position is offered.—Address, P6852, The Engineer Office. P6852 A

REPRESENTATIVES WANTED for Northumberland and Durham, South Wales, and Leith District, to Push the Sale of Steam Pumps for Land and Marine Work, Electric and Belt-driven Pumps, Auxiliary Condensers, and Feed-water Heaters. Land and marine connection essential. Liberal commission.—Address, 1451, The Engineer Office. 1451 A

SITUATIONS OPEN (continued)

SECRETARY WANTED, Fully Qualified, to Take Entire Charge of commercial side of well-known Firm of Steel Constructional Engineers and Bridge Builders. "Varsity or public school man preferred. State fully qualifications with refs. and salary required in strictest confidence.—Address, P6853, The Engineer Office. P6853 A

STAINLESS STEEL.—VACANCY EXISTS in Company producing superior Stainless Steel, Stainless Iron, High-speed and the whole range of Special Alloy Steels. Qualification £3/4000. Preference given to gentleman with commercial experience and connection.—Address, P6879, The Engineer Office. P6879 A

CAPABLE CONSTRUCTIONAL STEEL WORK DESIGNING DRAUGHTSMAN REQUIRED for Architect's Office, Liverpool District. Knowledge of Reinforced Concrete an advantage, but not essential. State age, experience, and salary required.—Address, 1458, The Engineer Office. 1458 A

DRAUGHTSMAN, Experienced in Lay-out of Rolling Mills and Miscellaneous Plant. Must be quick and reliable. State salary required. Good prospects.—Address, 1490, The Engineer Office. 1490 A

DRAUGHTSMAN REQUIRED by a Firm of Manufacturing Engineers. Must be thoroughly experienced in the Design of High-speed Air Compressors of all types, and Winding Engines, steam and electrically driven.—Address, stating age, full particulars regarding experience, and salary required, 1394, The Engineer Office. 1394 A

DRAUGHTSMAN, 25 to 35, Specialised in Hydraulic Machinery and Cranes. State fully experience, age, and salary; only qualified men need apply.—Address, 1495, The Engineer Office. 1495 A

DRAUGHTSMEN WANTED, Experienced in Railway Rolling Stock Construction.—Apply by letter, giving details of experience and wages required, THE BIRMINGHAM RAILWAY CARRIAGE and WAGON CO., Ltd., Smethwick. 1485 A

DRAUGHTSMEN WANTED; Two First-class Men, used to Details and Pipe Arrangement for Marine Diesel Oil Engines. State full particulars of experience, age, and salary required, enclosing copies of recent testimonials.—Address, 1457, The Engineer Office. 1457 A

DRAUGHTSMAN, with Good Knowledge Traction Motors, Electric Vehicles, &c., capable of planning and designing jig and tool lay-outs. Only those with good electrical experience need apply; £5 per 44 hours' week; London district.—Address, 1480, The Engineer Office. 1480 A

LOCOMOTIVE DRAUGHTSMAN WANTED for North-East District, thoroughly experienced in Contractors' Sketch Designing and Estimating; only such need apply, giving full particulars, age, experience, and salary required.—Address, 1486, The Engineer Office. 1486 A

OLD-ESTABLISHED CONSTRUCTIONAL FIRM in the North REQUIRE the IMMEDIATE SERVICES of a LEADING DRAUGHTSMAN qualified to assume control of a large drawing-office in the absence of the chief. Applications are invited from experienced men of strong personality, capable of applying latest modern practice to workshop details. Remuneration will be at the rate of from £400 to £500 a year, according to ability.—Address, 1447, The Engineer Office. 1447 A

STRUCTURAL DRAUGHTSMAN, First-class Man, able to Design, Detail, and Estimate Quantities. Excellent prospects.—Apply by letter only, stating age, details of experience, and commencing salary expected, to Sir WILLIAM ARROL and CO. (Swansea), Ltd., King's Dock Works, Swansea. P6858 A

TEMPORARY DRAUGHTSMAN WANTED for at least 12 months. One with Crane Experience and B.Sc. Degree preferred.—Address full particulars, 1460, The Engineer Office. 1460 A

FOREMAN for GUN-METAL FOUNDRY; Young, energetic, capable of making high-class Hydraulic Castings and experienced with Moulding Machinery and up-to-date methods.—Address, 1453, The Engineer Office. 1453 A

LONDON CONSTRUCTIONAL ENGINEERS REQUIRE ASSISTANT FOREMAN, thoroughly experienced in all trades (Tempiet Making, Plating, &c. &c.), with knowledge of and competent to fix piecework prices.—Apply by letter, stating full particulars and salary required, to Z. E. 684, care Deacon's, Leadenhall-street, E.C. 3. 1459 A

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SITUATIONS OPEN (continued)

TOOLMAKERS WANTED as Section Chaive Men in the manufacturing departments of large factory near Glasgow. Please give particulars of technical and practical training, age, &c.—Address, "TOOLS," Wm. Porteous and Co., Advertising Agents, Glasgow. 1468 A

ESTIMATOR REQUIRED, Accustomed to Tendering for Electric Motors, Generators, &c. Applicants state age, education, experience, and salary required.—Address, 1481, The Engineer Office. 1481 A

SITUATIONS WANTED

WANTED, POSITION as ENGINEER or TECHNICAL ASSISTANT; trained engineer, shops, D.O., complete gasification plants, high-pressure gas distribution; recently assistant to consulting engineer, lay-out of plants, foundations, &c.; age 44, married; permanency.—Address, P6892, The Engineer Office. P6892 B

WANTED, POSITION of ENGINEERING SHOP MANAGER; good organiser, with good testimonials, having held similar position with prominent engineering firms.—Address, P6824, The Engineer Office. P6824 B

A COMPETENT ENGINEER (35) SEEKS POSITION as MANAGER or ASSISTANT to MANAGING DIRECTOR or other responsible post with Iron and Brassfounders and/or General Engineers at home or abroad. First-class training and wide practical and commercial experience with firms of high repute. Full knowledge of all departments of the trade. Fully accustomed to responsibility. Ten years as manager and superintendent of works. Specialist in non-ferrous alloys production and their general application. Well known and very highly recommended.—Address, P6867, The Engineer Office. P6867 B

ADVERTISER (Age 29), with Sales Organising ability, DESIRES progressive APPOINTMENT, preferably in North of England; good selling record, trained in mech. engineering, first-class credentials.—Address, P6890, The Engineer Office. P6890 B

A MECHANICAL-ELECTRICAL ENGINEER, 15 years' selling experience with manufacturers, now DESIRES responsible POSITION, London export merchants. Fluent French and German; well travelled.—Address, P6862, The Engineer Office. P6862 B

ADVERTISER, a Public School Man, 34, 2 Years university, 5 years' apprenticeship, fully qualified mechanical engineer, A.M.I.M.E., REQUIRES permanent APPOINTMENT at home or abroad. Previous posts include assistant works manager, works manager; has experience in Near East; speaks French, Arabic.—Address, P6836, The Engineer Office. P6836 B

AIRCRAFT DESIGNER, Having Wide Experience of land and marine craft, good organiser, with large capacity for and who can influence work, DESIRES APPOINTMENT with go-ahead firm interested in metal construction.—Address, P6876, The Engineer Office. P6876 B

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M., 613, c/o Deacon's, Leadenhall-street, E.C. 1489 B

CIVIL ENGINEER, A.M.I.C.E., 14 Years' Experience both as engineer on contracts and on supervision of labour, WANTS POST; steel and concrete buildings, foundations, railways, &c.—Address, P6882, The Engineer Office. P6882 B

CIVIL ENGINEER, SURVEYOR, CLERK of WORKS; take charge works extensions, power stations, mansions, houses, roads, sewers, reinforced concrete, set out, plans, supervision and quantities.—E., 1, Davy-avenue, Scunthorpe, Lincs. P6881 B

ENGINEER and CHEMIST, Late Works Manager, SEEKS POST where 40 years' mechanical and civil engineering and manufacturing experience are valuable.—E., 11, Arodene-road, London, S.W. 2. P6874 B

ENGINEER, B.Sc. (Lond.), Assoc. M. Inst. C.E., formerly on staff of leading railway, now with constructional firm, DESIRES CHANGE with good prospects. Experienced all classes structural work, buildings, roofs, bridges, &c.; 15 year shops, drawing-office, outside experience; used control staff, entire responsibility. Royal Engineer officer during war.—Address, P6865, The Engineer Office. P6865 B

ENGINEER REPRESENTATIVE; Sales, Erection, general experience, 18 years' connection North-East Coast, steam and power users, also London area, REQUIRES POSITION or AGENCIES in North of London district. Excellent references.—Address, P6839, The Engineer Office. P6839 B

ENGINEER (34), with Long Experience in Several branches of mechanical engineering, shops, D.O. and managerial depts., specially conversant with rotary newspaper magazine and other printing presses, good electrical exp., excellent testimonials, last position supervising engineer to group of five factories (large and medium steel), DESIRES APPOINTMENT.—Address, P6837, The Engineer Office. P6837 B

ENGINEER (33), Experienced in Production and running of steam engines, DESIRES POSITION in Power Station, home or abroad.—GREGORY, Aldeburgh, Suffolk. P6869 B

ENGINEER, Mechanical (Age 37), Experience 22 years, late manager small works (70 hands), SEEKS RE-ENGAGEMENT; motor car work or general.—Address, P6856, The Engineer Office. P6856 B

ENGINEER, Mechanical and Electrical, DESIRES POST, Works Engineer. Sound shop and D.O. experience, gas, chemical, steam, &c., works maintenance and erection. At liberty near future.—Address, P6859, The Engineer Office. P6859 B

ENGINEERING DRAUGHTSMAN (34) REQUIRES JOB; 13 years' shops and D.O. experience on mechanical filtration, refrigeration, contractors and general machinery.—Address, P6894, The Engineer Office. P6894 B

EXPERT DESIGNER, Coal-cutting Machines, OPEN for ENGAGEMENT, all types, electric and compressed air.—Address, P6877, The Engineer Office. P6877 B

EXPORT TRADE.—ENGINEER (36), with Ten years' Australian experience, thorough knowledge markets and conditions, personal knowledge principal buyers, OPEN for ENGAGEMENT.—Address, P6878, The Engineer Office. P6878 B

INTELLIGENT BOY REQUIRES SITUATION in Engineering Works; age 15; slight knowledge of machine drawing; ex. refs.; small premium if required.—T. W., 387, New Cross-road, S.E. 14. P6878 B

GENERAL MANAGER, with Many Years' Experience with large automatic machinery manufacturing firm, is OPEN for similar APPOINTMENT. Proved administrator and business developer; highest qualifications.—Address, P6769, The Engineer Office. P6769 B

JUNIOR, Aged 17½, with 2 Years' Technical Training, SEEKS POSITION in office of civil, mechanical, or structural engineers. Small remuneration to start.—Address, P6897, The Engineer Office. P6897 B

MECHANICAL ENGINEER, Englishman, Aged 27, at present in India, SEEKS POST, Charge or Erection of Mill, Pumping or other Plant, &c.; varied experience; free June 1923.—Address, P6816, The Engineer Office. P6816 B

SITUATIONS WANTED (continued)

MECHANICAL ENGINEER SEEKS SITUATION as Maintenance Engineer to Factories or Manager Repair Shops. Good all-round man.—Address, P6887, The Engineer Office. P6887 B

PRODUCTION ENGINEER (42), Life Experience in U.S.A. and England, production and cost systems, capable of entire charge, SEEKS CHANGE.—Address, P6831, The Engineer Office. P6831 B

PUBLIC SCHOOL MAN (24), 4 Years' Practical experience, marine engineering, DESIRES DRAWING-OFFICE or other POSITION.—Address, P6857, The Engineer Office. P6857 B

SKILLED ENGINEER SEEKS SITUATION; thoroughly accustomed to marine installation; 11 years' experience.—Address, P6860, The Engineer Office. P6860 B

STOREKEEPER (Experienced) SEEKS an ENGAGEMENT, any capacity; thoroughly conversant in organising and controlling stores depts.—Address, P6880, The Engineer Office. P6880 B

TO FIRMS REQUIRING REPRESENTATIVE or WISHING to EXTEND PRESENT BUSINESS in INDIA and FAR EAST.—ENGINEER (33), accustomed responsibility and hard work, returning from India April, 1923, DESIRES NEGOTIATE ENGAGEMENT as Branch Manager or Assistant; 10 years' experience manufacturing, maintenance, purchasing, sales, all classes engineering machinery and appliances, well educated, good address, capable taking charge sales or manufacturing side, well up shipping accounts, correspondence, publicity, highest references; willing to travel.—Address, P6747, The Engineer Office. P6747 B

TO PUBLIC WORKS CONTRACTORS AND CONSTRUCTIONAL ENGINEERS.—CIVIL ENGINEER (39), A.C.G.I., A.M.I.C.E., ex-officer, 16 years' experience public works, India, SEEKS EMPLOYMENT at home in any suitable capacity; small salary accepted to start.—Address, P6835, The Engineer Office. P6835 B

WORKS MANAGER, Excellent Long Service record with general engineers and ironfounders, SEEKS SIMILAR POSITION; well-educated man, with sound works and D.O. experience, good organiser, successful control of labour; moderate salary.—Address, P6884, The Engineer Office. P6884 B

CHIEF DRAUGHTSMAN (Machine Tools), 25 Years experience, REQUIRES similar POSITION or Manager; good organiser, successful control of labour.—Address, P6812, The Engineer Office. P6812 B

DRAUGHTSMAN (Age 31) DESIRES SITUATION; exp., 7½ yrs. works and D.O., with large rly. wks., 2½ yrs. hand cranes and mechanical structure design, 5½ yrs. motor and aircraft mach. and gen. mech. designs.—Address, P6891, The Engineer Office. P6891 B

DRAUGHTSMAN and ENGINEER, 12 Years' Shops, 12 years office, London, all-round experience, salary from £5 to £6; can take charge or as assistant to engineer.—Address, P6864, The Engineer Office. P6864 B

MECHANICAL DRAUGHTSMAN (27) SEEKS POST with General Engineering Firm, London district; disabled ex-Service man. Interview solicited.—Address, P6883, The Engineer Office. P6883 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.,
46, Watling Street, London, E.C. 4.
Established seventy years.

PARTNERSHIPS, DIRECTORSHIPS, MORTGAGES, DEBENTURES, BANK OVERDRAFTS, EXTRA CAPITAL, the FINANCE of CONTRACTS, OVERTRADINGS. The highest class of business only dealt with by private treaty. NO loans.—BUSINESS BROKERS, 49, Dover-street, W. 1. 1449 C

MISCELLANEOUS

A BROCHURE on "ENGINEERING SALESMANSHIP and SALES MANAGEMENT," with particulars of a SPECIAL COURSE of TRAINING, will be sent post free on application to SECRETARY, THE INSTITUTE OF ENGINEERING SALESMANSHIP, 323, Oxford-road, Manchester. P6471

CONSULTING CIVIL ENGINEER, Experienced in negotiating with foreign Governments, obtaining concessions for public works, reporting and advising on railway, hydro-electric power, and other projects, OPEN to SIMILAR WORK. Fluent French and Italian, good knowledge of Spanish.—Address, P6745, The Engineer Office. P6745 I

ENGINEERS, with Assured Turnover of £100,000 per annum shortly, are WISHFUL to FIND MANUFACTURING FIRM with ample plant and resources, line similar to high-class machine tools, largely piece work. Full particulars will be given in confidence to suitable applicants.—Principals, or their Solicitors or Accountants, write in first instance to BOOTE and DUTTON, Solicitors, 22, Booth-street, Manchester. 1417 I

ENGINEERING, CHEMICAL or SCIENTIFIC SPECIALITIES DEVELOPED, MANUFACTURED and FINANCED.—L., W. H. Smith and Son, Bookstall, Staines. P6843 I

SPANISH ORES AND MINERALS.—Pyrites, Iron, Manganese, Vanadium, Copper, &c. Inquiries solicited. SAMPLING AND VALUES. British firms represented on commission in Spain in technical work.
J. E. CUNNINGHAM, A.R.C.Sc., Apartado 960, Madrid. 1474 I

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DIVIDING HEADS for MILLING,
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SLOTTING and MILLING,
Write to
THE WHEELER MNFG. CO. Ltd.,
65F, Trench Crossing, Wellington, Salop.

FOR HIRE

FOR HIRE, PUMPS and WELL-BORING TOOLS for Contractors' Deep Wells, &c., 3in. to 24in. dia.—E. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No. 975 Hop. 833 E

FOR SALE or HIRE, ELECTRIC MOTORS, from 60 to 300 H.P.; PORTABLE STEAM ENGINES, from 8 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description; reasonable terms, immediate delivery.—J. T. WILLIAMS and SONS, 37, Queen Victoria-street, London, E.C. Tel., City 6938. Ex. E

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The Evolution of the Heavy Oil Engine.*

By R. E. MATHOT.

CONTRARY to a generally prevalent idea, it is to the Englishman Akroyd Stuart that we owe the first application of the oil engine working with automatic ignition after the introduction of the combustible into air previously compressed by the working piston. This cycle is quite different from that of Otto or of Beau de Rochas. The Diesel cycle may be regarded as a modification of the Akroyd cycle, for it operates on the same principle. The engine patented by Akroyd in 1890—two years before that of Diesel—burnt the charge at constant volume, whereas the Diesel engine burns it at constant pressure; but in other respects the Diesel cycle only differs from that of Akroyd in that the compression is higher—from 35 to 40 kilos. per square centimetre—say, from 500 lb. to 570 lb. per square inch—as compared with the 3 to 4 kilos. per square centimetre—say, from 42½ lb. to 57 lb. per square inch of Akroyd. The higher pressure itself produces a temperature high enough to bring about the ignition of the mixture.

If during the past twenty years the Diesel engine has been considerably developed, it is because the inventor, aided by scientific ability, found in his own country the financial and technical aid of the large works which he had the good fortune to be able to interest in his ideas.

During the same time, Akroyd Stuart, left, so to speak, alone, found a concessionnaire who would manufacture his engines on rudimentary thermodynamic lines. The low compression which was employed in his engines was not sufficient to ensure ignition without recourse being had to a hot spot, which is used to-day in two-cycle engines, the prototype of which is of Scandinavian origin. The engine was not economical, and its applications never went beyond that to small industrial motors. It was, it is true, made in numbers sufficiently great to be remunerative and to assure, after a few years, a modest competence to Akroyd Stuart, who actually lives retired in Australia and to whom the merit should be accorded of having been the inventor of the cycle which we are considering, and which appears to be about again to come into favour. Let us examine the reasons why:—

The Diesel motor, properly so called, which works on either the two-stroke or the four-stroke cycle, differs from the explosion or hot-bulb motor in that the progressive and gradual injection of the combustible towards the end of the period of compression, results in a combustion which is slow in comparison with the rapid and brusque deflagration which characterises the explosion motor. This slow combustion is the result of retarding the flow of combustible oil into the cylinder by means of a valve, the forms of which are infinitely varied. To overcome this resistance resort is had to the use of high-pressure injection air which is furnished by a two or three-stage compressor forming part of the engine. In an ordinary Diesel engine with a compression of from 30 to 35 kilos. per square centimetre—say, from 430 lb. to 500 lb. per square inch—the pressure of the injection air is generally as high as from 65 to 70 kilos. per square centimetre—say, from 930 lb. to 1000 lb. per square inch; while in engines using oils with higher flash points in which the compression is often higher than 570 lb. per square inch, the pressure of the injection air may have to be as high as, or higher than, 1150 lb. per square inch. It is necessary to have these exceedingly high pressures in order not only to overcome the resistance of the pulveriser but the compression pressure as well. The latter is high enough to produce a temperature which is considerably in excess of that actually necessary to bring about the ignition of the combustible mixture, but it is necessary in order to counteract the cooling which results from expanding the injection air from a pressure of 1150 lb. per square inch into a space containing air compressed to only from 430 lb. to 570 lb. per square inch. Matters proceed, therefore, in a vicious circle in which an expensive excess of temperature is provided to make up for a loss which cannot be avoided. The injection air absorbs for its compression 10 per cent. of the effective horse-power of the engine, and that is why the efficiency of a four-stroke Diesel engine is only about 75 per cent. The compressor, which is a delicate and complicated machine, usually comprises two or three cylinders with their mechanical control gears, cooling arrangements, piping, air receivers and valves. In cost it represents from 8 to 12 per cent. of the total cost of the engine, while it can be shown by statistics that 70 per cent. of all breakdowns, and even of the fatal accidents, which can be laid at the door of Diesel engines, are attributable to compressors and their accessories.

It is known, for instance, that if by lack of care or of supervision, lubricating oil of improper quality, or even good oil in excess, be allowed to accumulate in certain parts in contact with compressed air at high temperature, spontaneous combustion may be set up which will generate such high pressures as to burst the compressor. It can also be urged against the injection of the combustible by means of high-pressure air that we have to regulate the output of the compressor by hand experimentally, while the engine is running, and as its load varies, or suffer the penalty of seeing the combustion injuriously affected when the engine is running on light loads in consequence of excessive cooling of the pulverised fuel with a too large volume or a too high pressure of air. In any case it is well known that even with the air accurately regulated the combustion engine† does not work well on light loads and the valves, piston and exhaust piping become prematurely coated with deposits of carbon, which are the result of defective combustion.

Let us now consider the pulveriser of combustion engines and ascertain why it is necessary to have properly regulated mechanical control—which is not the case with the pulverisers as fitted nowadays to explosion engines. The Diesel pulveriser is a piece of apparatus which requires delicate adjustment, for only quite a small rearrangement of the plates forming the labyrinth is required when it is being altered for fuels of various natures. Moreover, the needle valve which controls the inlet orifice is furnished with a packing gland which is only kept tight against the high pressures by very exact construction and specially careful attention, failing which the pulveriser leaks and tempts the driver to screw up his packing so tightly as to run the risk of allowing the valve to become fixed in the open position so that it cannot be closed by its spring. Such an accident might have a disastrous effect on the engine, which, under the influence of premature injection of fuel into air compressed to a pressure of 500 lb. to the square inch, might experience, not a slow combustion producing a pressure but little in excess of the compression pressure but a violent explosion, which might result—as in cases which have come within the writer's experience—in pressures rising to 1000 lb. or 1200 lb. per square inch or even more than that.

Diesel engine builders, therefore, find themselves confronted with the alternative of either making provision for excessive accidental pressures by giving to their engines, notwithstanding the resulting increase in weight and cost of construction, excessive dimensions or of building them for normal pressures and running the risk of their experiencing anything higher. Such a dilemma has not to be faced by builders of engines working on the Otto cycle, in which, with compression pressures varying between 250 lb. and 300 lb. per square inch, the explosion, even if it be premature, does not result in pressures exceeding 500 lb. to 570 lb. per square inch, so that the weight of the engine can be kept comparatively low.

While I am of opinion that the explosion motor is bound in the near future to be a very serious rival to the Diesel engine, the following facts with regard to the latter must, in fairness, be borne in mind. After more than twenty years of practical experience in the building of Diesel engines a machine has been evolved which, from the points of view of running and efficiency, does not leave much to be desired. Although, from the point of view of construction, there remain mechanical complications and the weight which necessarily react in an unfavourable manner upon the cost of building and installation, both two-stroke and four-stroke cycle Diesel engines have fought their way in marine work and in industrial establishments to an important position beside reciprocating steam engines and turbines of the highest efficiencies. Diesel engines, whether of the multi-cylinder vertical or of the single or double-acting horizontal types, are now made in units of 6000 horse-power or more, a size which is seldom exceeded by steam engines. They have, moreover, given abundant proof of their endurance capabilities under the most precarious and exacting conditions, as, for example, in the case of submarines.

As to the reduction in consumption of fuel, it is the result of the high-compression cycle, but the heat balance given below shows how much there is yet to be done in turning waste heat into useful work:—

	Per cent.
Expenditure of calories transformed into work plus friction	43
Loss in exhaust gases	22
Loss in circulation water	33
Loss in external radiation	2
	100

Turning now to the solid-injection or hot-bulb engine, which is too often wrongly designated "semi-Diesel," though its cycle only resembles that of Diesel, in that the ignition is automatic by reason of the high temperature resulting from the initial compression of the air.

From 1914 to 1918, when French engine builders were devoting all their science and energies to the production of war material, numerous English specialists were called upon to execute for their Government regular and important orders, not only for large marine motors, but also for small heavy oil engines of between 30 and 400 horse-power for the equipment of numerous stations for the defence of the coast. The same sort of thing took place in America, and it was under this stimulating influence that considerable advances were made in the production of two-stroke hot-bulb engines of the Scandinavian type, in the construction of which several firms were engaged before the war began. Among the best known in England were Wm. Beardmore and Co., Limited, Robey and Co., Limited, Petters Limited, the Campbell Gas Engine Company, Limited, and L. Gardner and Sons, Limited, of Patricroft. Concurrently with the building of these vertical engines, horizontal four-stroke motors have been developed and perfected, notably by such firms as Crossley Bros., Limited, Tangyes Limited, Ruston and Hornsby, Limited, and others. These firms have brought the four-stroke engine to such a point that it has become a serious rival to the Diesel engine as regards reliability in work and economy both in fuel consumption and first cost.

The simplicity of construction of the hot-bulb engine forms the chief merit claimed for it by its supporters, and, indeed, the absence of complicated valve gear and the simplicity of scavenging single out that type of engine as specially suitable for fishing boats and yachts, and for motive power in small industries in which it would not pay to put skilled mechanics in charge of the power plant.

It is astonishing, however, that the Scandinavian, the American, French, or the English builders who have constructed motors of from 360 to 400 horse-power have never departed from the original design, and never set themselves to improve these interesting machines from the point of view of thermal efficiency, which is scarcely above 25 per cent., by raising, with this object, the compression pressure, which varies, in different engines, between 7 kilos. and 15 kilos. per square centimetre—say, from 100 lb. to 210 lb. per square inch—so as to avoid the necessity of having to heat the vaporiser at starting or by doing away with crank case compression, which is often uncertain in its effect and which results in a loss of lubrication, and at the same time involves covering up and hiding from view the heads of the connecting-rods, which are so exposed to heat in this type of engine.

Let us now return to the four-stroke explosion motors and compare them with Diesel engines operating on the same cycle.

As built at the present time, they have no exterior uncooled vaporiser, and the injection of the combustible is made directly into the combustion chamber, which is carefully cooled by water circulation. I have said that a compression of from 500 lb. to 570 lb. per square inch results in a temperature which is considerably higher than is actually necessary to bring about the ignition of mixtures of air and the heavy oils which we are considering. In fact, while these temperatures vary between 800 deg. and 900 deg. Cent. in Diesel engines, they scarcely rise to 500 deg. Cent. in explosion engines; moreover, it is only necessary to raise the compression pressure to, say, from 285 lb. to 340 lb. per square inch to ensure ignition without misfiring as soon as the combustible is injected. It is true that to the temperature inherent in this compression is added the heat of the cylinder walls and, more particularly, of the bottom of the piston, which is given a certain thickness so as to form a magazine or reservoir of heat. It is by reason of this conjunction of thermal elements that the new engine does without, not only excessive compression pressure, but also with injection air, and that it consequently dispenses with all the complicated mechanism included in the compressor, the air reservoir, the air injection tubing, and the mechanical control of the needle valve and its gland, of which I have discussed the objections from the points of view of operating charges and first cost.

The hot-bulb engine is, in fact, satisfied with mechanical injection, by means of which, at the proper moment, the fuel is caused to mingle in a finely pulverised state with the compressed air at the head of the cylinder. And here a difficulty is encountered which, fortunately, has now been overcome, after long experiment. It consists in ensuring a pulverisation of the fuel to such a degree and into particles so infinitely small that each one is perfectly surrounded by sufficient air for complete combustion, and that at the same time the whole body of the mixture lends itself to the rapid propagation of the flame.

Actually the liquid thus pulverised has the appearance of a mist or fog of combustible which approaches very nearly to the condition of a perfect gas from the point of view of combustion. The pulveriser, by means of which this condition is obtained, is furnished with a nozzle pierced with an orifice varying between 0.3 mm. and 1.0 mm. in diameter, according to the size of the engine. By means of it the combustible is given a speed of delivery of from 100 m. to 150 m.—say, from 330ft. to 500ft.—per second under a pressure of from 80 kilos. to 130 kilos. per square centimetre—say, from 1340 lb. to about 2000 lb. per square inch—produced by the injection pump. In some engines, such, for example, as the Vickers, this pressure has even been taken to as high as 1000 kilos. per square centimetre, or round about 14,000 lb. per square inch, without any of the fittings suffering more than do hydraulic presses, for example.

It should be added that the latest types of pulverisers are furnished with a needle valve, which is maintained in position in the nozzle by means of a powerful spring. When the stroke of the pump forces the oil forward the needle is raised under the action of the pressure and is lowered so as to close the nozzle towards the end of the injection, when the pressure has diminished. The introduction of the combustible and its pulverisation are the result of a veritable

* Translated from a paper presented at the International Congress on Liquid Fuel at Paris, October 12th, 1922.

† Monsieur Mathot distinguishes between combustion engines = constant pressure, and explosion engines = constant volume. —ED. THE E.

water-hammer effect, which makes it certain that the discharge is cut off suddenly and completely so that no dribbling of oil takes place from the nozzle towards the end of the pulverisation, forming drops which might escape complete combustion and occasion deposits of carbon.

I propose to examine in a future paper more particularly devoted to engines designed to work with vegetable oils, the rules of construction to be followed so as to obtain the highest thermal and mechanical efficiencies in engines belonging to the class which I am comparing with Diesel engines. It must be realised, however, that, though with the latter engines from 300 to 500 horse-power is commonly obtained from each single-acting cylinder, it has never been attempted to reach a greater power than from 150 to 175 horse-power per cylinder with an explosion motor under similar conditions. The problem which will have to be solved in order to reach higher powers with explosion engines will be to find a means of diffusing perfectly throughout a large enclosed space oil pulverised mechanically by the aid of pressure alone and without the aid of injection air. It is apparently by multiplying the number of pulverisers delivering into the same cylinder head that we shall be enabled to build explosion engines of the same power per cylinder as Diesel engines, and at the same time preserve their essential quality of simplicity. To prove that this simplicity of construction is not obtained at the expense of fuel consumption, it will suffice to say that some explosion engines just recently built to my designs, notably in France by La Société des Anciens Etablissements Weyher et Richmond, and in Belgium by La Société des Nouvelles Usines Bollinckx—which engines start instantly from the cold, as do Diesel engines—are regularly developing an effective metric horse-power-hour with a consumption of less than 260 grammes of heavy oil having a calorific value of 10,000 calories per kilogramme. In British units these figures represent 0.441 lb. of oil with a calorific value of 18,000 B.Th.U. per pound. It must be remembered, however, that the metric horse-power is about 1½ per cent. less than the British horse-power. These figures represent an effective thermal efficiency of nearly 32 per cent.

Other things being equal, the losses in these engines—heat in the exhaust gases, heat in the circulating water, and radiation losses—are practically the same as in Diesel engines. But the latter have a mechanical efficiency of only 75 per cent., while the explosion engines with which I am comparing them reach a mechanical efficiency of from 85 to 87 per cent. There is, therefore, a gain of from 10 to 12 per cent. in favour of the explosion motor, and the figure is full of promise when it is considered that the gain is realised with a compression pressure of from 18 kilos. to 24 kilos. per square centimetre—say, from 260 lb. to 340 lb. per square inch—which means an initial explosion pressure of from 430 lb. to 500 lb. per square inch, which is equivalent to the compression pressure in Diesel engines. Taking it, however, that the new engine with mechanical injection and moderate compression has only the same consumption as the Diesel engine, it still has the advantages of simplicity and less cost to build, which amounts to about 20 per cent.

What are the best figures that a Diesel engine can show? There are those I obtained with a Diesel-Koerting engine working in California in 1914. With it, when on trial, an effective thermal efficiency of 36 per cent. was arrived at—or an indicated thermal efficiency of 40 per cent. I may here say that though I have tested dozens of Diesel engines of one type or another, both in Europe and in America, I have never myself met with such results as these. But exceptional as they may seem, we can compare them with the remarkable thermal efficiency of 40 per cent. reached by the Still engine, which constitutes a praiseworthy and daring attempt to recover the considerable losses of heat which occur in internal combustion engines. It is characterised by the recuperation of a portion of the heat lost in the exhaust gases and in the circulating water, with the resultant production of a certain quantity of steam under pressure. The latter does a certain amount of work in the cylinder of the engine by acting on the opposite face of the piston to that which receives the impulse of the gases of combustion. The water in the cylinder jacket is raised to a temperature of about 180 deg. Cent., which corresponds to a steam pressure of about 10 kilos. per square centimetre—say, 140 lb. per square inch—which has the effect of partially counterbalancing the pressure inside the cylinder, while it imparts a uniform temperature over the whole of the surface and thus reduces the inequalities of expansion which are so prejudicial. The face of the piston is cooled by the steam, which, as a result, is itself heated or even superheated by its contact with it. The exhaust gases are discharged from the cylinder at a higher temperature than is the case with engines of the ordinary type, but the additional heat is, in its turn, recovered in heating the circulating water before it enters the envelope in which it is vaporised. In what I will call the "water-steam circuit" is inserted a small steam generator, the capacity of which is made to suit the power of the engine and the duty which it has to perform. It contains a reserve of steam and may be made use of for starting up by the aid of an external source of heat—such as a petrol burner—in the event of a long stoppage.

In addition to its high thermal efficiency the Still engine has also the advantage of being exceptionally flexible in operation. It can, in fact, be started on load, and sustain, if need be, a load double the normal—qualities hitherto only possessed by the steam engine. It has already passed its experimental stage and is being built in sizes varying from 10 to 1000 horse-power. And the Still engine is of the explosion type with the fuel injected mechanically into compressed air. Its remarkable performances confirm the opinion which I have expressed in the foregoing as to the advantages of moderate pressures applied to engines without the use of compressed air for fuel pulverisation.

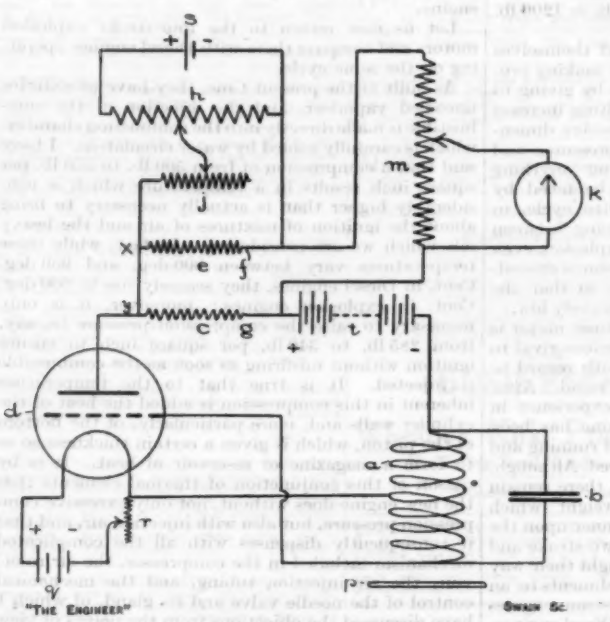


FIG. 1—DIAGRAM OF CONNECTIONS

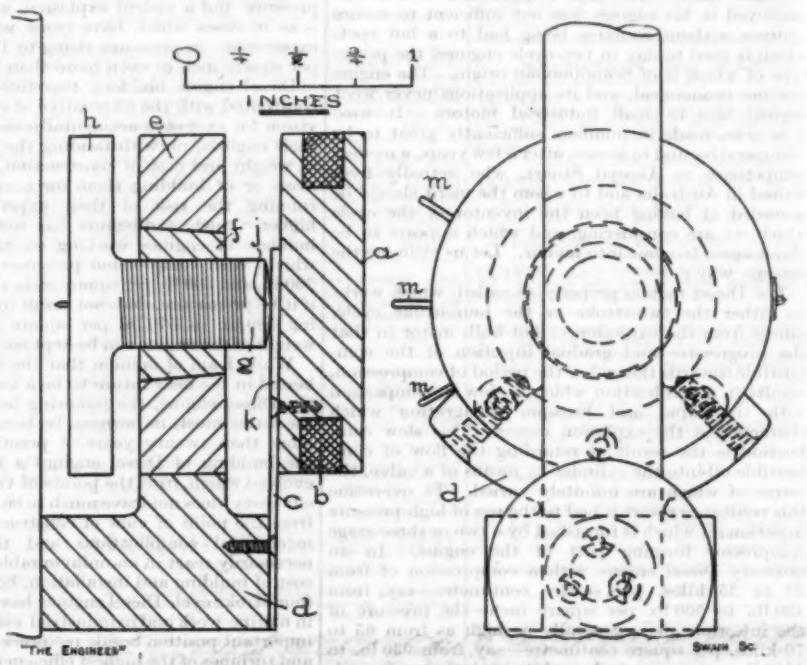


FIG. 2—OSCILLATING COIL AND ITS MOUNTING

Precision Measuring Instrument for Small Motions of Solid Bodies.

By H. A. THOMAS, M.Sc., of the National Physical Laboratory.

THE problem of measuring small motions of the order of one-thousandth to one-millionth of an inch is one that has not so far been successfully solved. Means for measuring a definite length within these limits are common, but the permanent and accurate measurement of the motion of a body relative to another presents difficulties which hitherto have only been partially solved in special cases by optical methods. The optical lever is a well-known means of magnification and for the permanent recording of the motion of a member, but in cases where pulsating or vibratory motions are encountered, the inertia of the moving mirror system may materially affect the initial motion, especially when the moving body possesses very little more mass than the attached recording system. In all optical methods, however, inaccuracies are common and corrections for the added moving masses necessary. The object of the new instrument, about to be described, is to provide a method free from these defects.

The apparatus consists essentially of a high-frequency electrical oscillator in which the amplitude of the oscillation is varied by the motion of the body under observation. The generator of the electric oscillations consists of a thermionic vacuum tube supplying an electric oscillating circuit, whose constants are varied by the relative position of the moving member with respect to a coil, forming part of the closed circuit. Fig. 1 gives a diagram of connections and explains the action.

The valve *d* and its usual oscillatory circuit produces a high-frequency oscillating current in the circuit consisting of the inductance *a* and the condenser *b*. A high resistance *c* of about 2000 ohms is inserted in the anode circuit and the normal difference of potential existing across this resistance is balanced by an auxiliary circuit, consisting of the battery *s* and the resistances *e* and *j*. The two points *f* and *g* are therefore adjusted to be normally at about the same potential, and any subsequent change is detected by means of the high-resistance galvanometer *k* connected across the two points *f* and *g*.

If now a metallic body *p* be brought into the oscillating field of the coil *a*, the field extending for some little distance from the actual ends of the winding, a change of conditions occurs, energy being absorbed by the metal and a redistribution of current taking place in the oscillating circuit. The effect of this redistribution is to change the normal direct current existing in the anode circuit of the valve, and thus to change the E.M.F. across the resistance *c*. Since the balancing E.M.F. existing across *e* remains constant, a difference of potential is set up between the two points *f* and *g*, and the galvanometer is deflected. If the body *p* move a slight amount relatively to the coil *a*, the galvanometer will follow the motion, and if its readings are calibrated, the motion may be accurately measured.

In the case of a definite and constant movement, an ordinary d'Arsonval galvanometer is suitable, but in the case of pulsating motions and vibrations, a galvanometer capable of following rapid potential changes must be employed. An Einthoven string galvanometer fulfills the condition in this case, and since the moving part consists of a thin glass or quartz fibre, having an almost negligibly small mass, it is capable of following alternating E.M.F.s up to a frequency of about 1000 per second, depending upon the tension and consequently the sensitivity of the fibre.

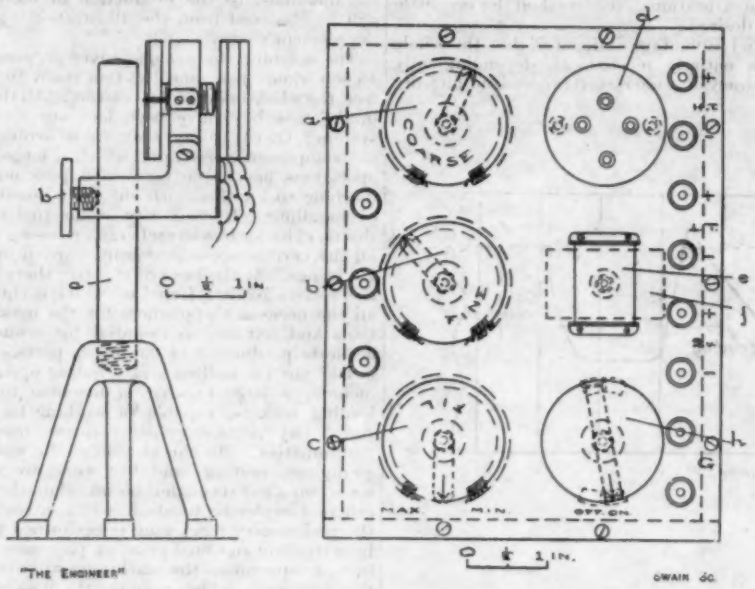
The method of calibration is entirely mechanical, and consists in mounting the oscillating coil so that it may be moved definite distances axially with respect to itself by means of a graduated micrometer. An approximately similar deflection on the galvanometer can thus be produced by moving the coil towards the moving body. This method of calibration possesses the great advantage that not one electrical instrument is necessary either in the operation or the calibration, and therefore the valve conditions are never critical.

The movements of the galvanometer are, of course, photographically recorded, and constitute a permanent record of the motion, together with the calibration.

It is clear that the apparatus resolves itself into three

essentially distinct parts—the oscillating coil with its mounting and micrometer control, the valve and its attendant circuit, and the recording galvanometer.

The former of these, the coil and its mounting, is illustrated in Fig. 2, in which the coil *a*, consisting of about 100 turns of No. 30 S.W.G. insulated copper wire wound on to a 1½in. ebonite bobbin, is attached to a steel leaf spring *c*, which in turn is fixed to the casting *d* sliding on a tripod column. This coil may



FIGS. 3 AND 4—TRIPOD STAND AND VALVE CONTROL PANEL

be moved axially by means of the micrometer screw *g*, and its movement is read by means of the graduated head *h*. The coil may be placed by means of the tripod stand *a*—Fig. 3—which gives the assembly of this part of the instrument, near to the body whose movement is to be recorded.

Three leads run from this coil to the valve control panel, illustrated in Fig. 4. This consists of the valve holder *d*, the resistances *e*, the balancing potentiometers *a* and *b* with a switch *h*, the condenser *f* and the filament rheostat *c*. The high-tension battery supplying the valve may consist of a series of dry cells giving about 30 volts, and the filament is lighted by a small 4-volt battery. A small 2-volt cell supplies the balancing circuit.

Now let us consider the method of operation in the case of the direct motion of a body. Bringing the coil about ½in. from the body, we adjust the balancing circuit to give an approximately zero reading on a d'Arsonval galvanometer, and then we allow the body under observation to move. The shift of the galvanometer is noted. The micrometer screw is then rotated, so moving the coil a small distance and bringing the reading of the galvanometer somewhere in the neighbourhood of the original zero. The deflection of the body is then $\frac{\delta^1}{\delta} \times x$, where δ^1 is the original deflection, δ is the calibration deflection, and x is the corresponding micrometer reading.

The galvanometer calibration is found to obey a linear law for small motions. If the motion is much greater, a calibration of the shunted galvanometer can always be obtained by taking readings for various movements of the coil produced by rotating the micrometer screw.

Small motions of the order of one-millionth of an inch can in this way be accurately recorded, and yet by shunting the galvanometer heavily, motions of the order of one-eighth of an inch can be equally accurately measured.

For movements of pulsating or vibratory motions,

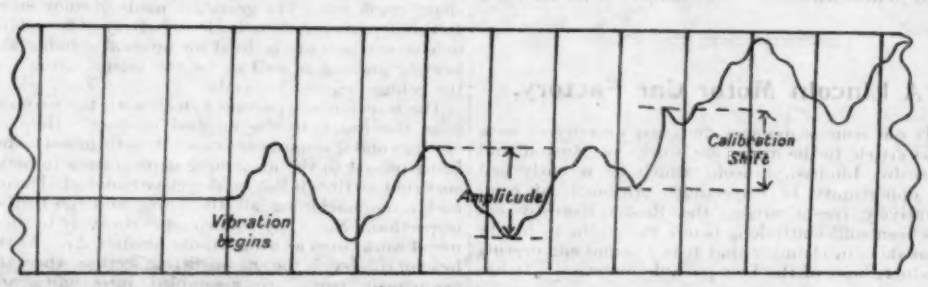


FIG. 5—DIAGRAM OBTAINED FROM A VIBRATING BODY

an Einthoven string galvanometer is substituted for the d'Arsonval instrument, and then, after allowing the vibrating body to produce its record on the galvanometer film, the whole record is bodily shifted by a known movement of the calibrating micrometer. This gives a direct calibration without the interruption of the moving member.

Fig. 5 gives a diagram of the type of record obtained by a vibrating body, and shows how the calibration is performed without disturbing its motion.

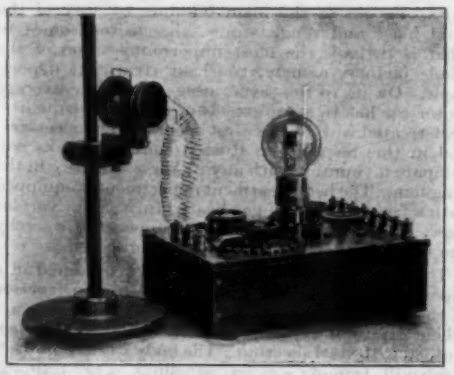


FIG. 6—MOVING COIL AND CONTROL PANEL

Fig. 6 illustrates the moving coil and its mounting, together with the electrical control panel, and the reproduction of a portion of a film record—Fig. 7—gives an idea of the size of the final photograph, and, consequently, the effective accuracy of measurement. However, it must be remembered that these films were taken on a wireless receiver, and give variations of signal strength in the telephones. For this purpose the magnification has to be about 300, and the moving fibre is consequently seen as a band about 2 mm. wide. For the actual purpose in hand, this magnification is not desired, and the line will be very sharp and thin.

The graph—Fig. 8—clearly shows the method of operation. It will be seen that the motion of the plate has been plotted against the change in anode current (not the galvanometer deflection), and the linear part of the curve is clearly shown. It is at this part that the accurate measurements are taken, and the steepness of the curve at this point shows why the sensitivity is so enormous. It will also be noted from the same curve that when the plate is about 1 cm. from the coil the anode current remains stable. Thus the action is extremely local, external movements of metal having no effect at all on the deflections. This is a very important advantage, since a capacity type of instrument would be effected by strays, and most magnetically operated delicate instruments are very sensitive to stray fields.

The method of operation and general utility of the apparatus may best be explained by reference to a few of many possible important applications.

Let us therefore consider, first, a method for quickly measuring mechanical extensions in ordinary tensile and compression tests. Two clamps at a known distance *d* along the specimen—Fig. 9—support the coil and a small metal plate about ¼in. apart. The usual apparatus is connected to the coil. Then it is only necessary to perform the required operations on the bar, and record photographically the relative small motion between the coil and the plate. The calibration may then be performed, and the final film will be somewhat as depicted in Fig. 10.

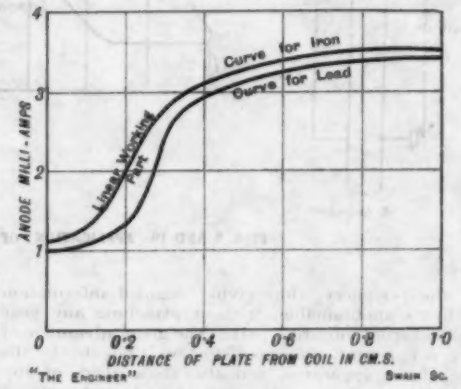


FIG. 8

Here we have a diagram showing all that is required for most commercial tests, with the requisite calibration and time divisions, which, of course, would be synchronised with the applied load. These time divisions are produced by a synchronous marker operated by a standard frequency tuning fork, a standard accessory of every Einthoven galvanometer. The whole chart is obtained in one operation, and gives far greater accuracy than the present tedious method of plotting elongations, besides which the rate of application of the load can be increased to any value quite irrespective of the recording gear.

The method is therefore of great utility in analysing the transient conditions existing in all types of civil and mechanical structures when subjected to live loads. Particular examples are bridge structures and cantilevers under live loads, and also struts of all types. The actual movements of a bridge girder under any test conditions can thus be recorded, and in this case the girder itself takes the place of the moving metallic plate.

By a slight modification, it is apparent that torsion

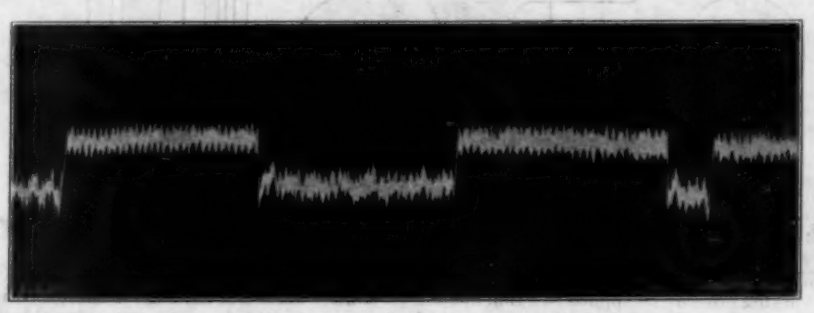


FIG. 7—PHOTOGRAPHIC RECORD—THREE-FIFTHS FULL SIZE

tests may be similarly treated. In Fig. 11, let a small plate of tinfoil *p* be attached to the specimen, and let the coil *c* be placed as before near to the plate.

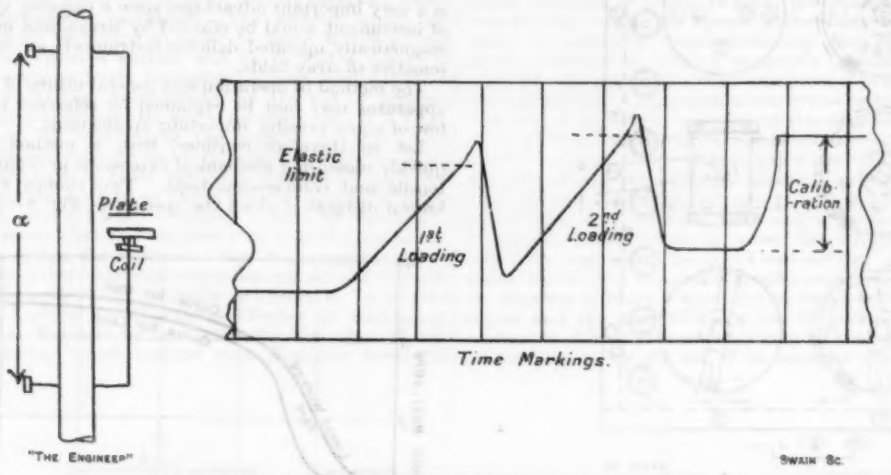
Then, when the displacement δ is measured as in the previous cases, we have the relation $\sigma = \frac{\delta}{d}$, where σ is the angular twist and d is the axial distance of the coil centre.

In all these testing cases, the inherent advantage

of the method is that problems involving unsteady, vibrational, or pulsational loads can be as easily solved experimentally as the simpler ones involving only steady conditions.

We will now turn to the measurement of vibrations. By bringing the oscillating coil in proximity with the vibrating member, the vibration of the particular surface nearest to the coil will be recorded, if the body is metallic. In the case of a non-metallic body, a thin sheet of tinfoil gummed to the particular surface under observation is all that is required, and in most cases the added inertia will not seriously affect the amplitude, form or frequency of the vibration.

Thus the outer contour of an engine may be "explored," and records taken of each and every part



FIGS. 9 AND 10—APPLICATION OF INSTRUMENT TO TENSILE TESTING

of the periphery, thus giving detailed information hitherto unobtainable, without attaching any gear to the actual vibrating part. The great advantage of this is apparent, since no distortion is possible by the use of the apparatus, and also the absence of any attachment gives wide applicability, and ease of measurement.

The particular range of utility is likely to be in the more careful investigation of reciprocating forces and their effects in steam and internal combustion engines, and certainly in the latter case the information obtained should prove of the utmost use in the future improvement of the design of vibrationless engines, since the sources of trouble can be so easily located.

Further applications under the section of vibrations are apparent, such as the measurement of the stresses in airship and aeroplane structures during flight, shear stresses in propellers in air, and water screws under power.

In the case of vibrations below about 100 per second, the actual wave form is truly depicted on the photographic film.

Lastly, we have to consider the application to the measurement of pulsating liquid or gaseous pressures.

If the varying pressure be applied to a thin metallic diaphragm, the natural period of vibration of which is sufficiently high to enable it to follow the pressure changes under consideration, then the movement of the diaphragm may be recorded as before, by fixing the oscillating coil near the opposite wall to the fluid. A rough sketch of the design is appended in Fig. 12. The fluid pressure p is applied to the diaphragm, and the coil is mounted near to the diaphragm, with a micrometer adjustment for calibration, the whole being enclosed in a simple type of case, as shown.

Calibration is, of course, performed by the application of static pressure to the closed chamber.

This apparatus is capable of measuring pulsating fluid pressures of the order of 100 per second, and in practice is limited by the mechanical and hydraulic considerations only.

In conclusion, it may be stated that in every case the limiting factor as regards the upper frequency limit is set by the galvanometer, and it may be noted that recently it has come to the author's notice that the latest Einthoven instruments are capable of responding to frequencies of the order of 10,000 per second. With such an instrument for photographically recording the vibrations, the method leaves little further to be desired.

The essential advantage claimed is that the whole calibration is entirely mechanical, depending only upon the accuracy of a micrometer thread, admittedly one of the finest standards that it is possible to work with, and also that since in no case is there any attachment to the moving body, the motion is in no way affected by the presence of the instrument.

Details of design are not submitted in this article, as these obviously vary in particular cases, and it is more important at the present stage of development to give a general survey of the many applications than to deal with restricted examples of its utility.

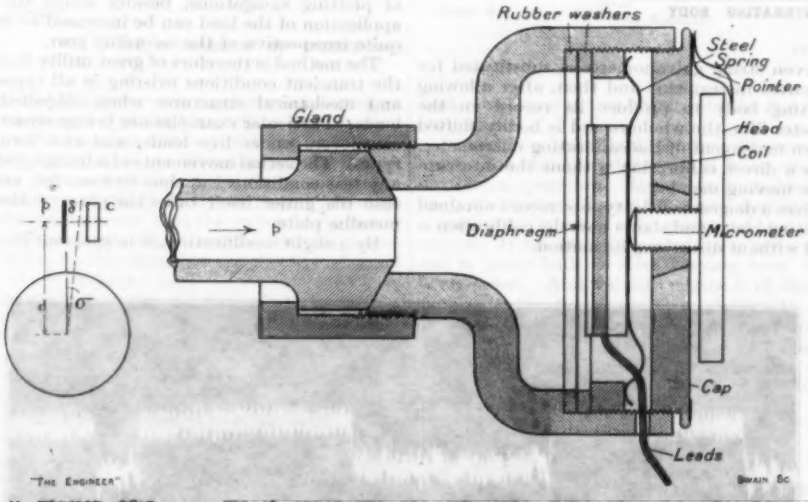


FIG. 11—TORSION TEST FIG. 12—APPARATUS FOR PULSATING FLUID PRESSURE MEASUREMENTS

A Lincoln Motor Car Factory.

IN our issue of January 26th last we referred in a brief article to the motor car works of Ruston and Hornsby, Limited, Lincoln, which we recently had an opportunity of inspecting. Although of comparatively recent origin, the Ruston-Hornsby car has been sufficiently long before the public to justify its makers in claiming that it is a sound engineering product, built of the best possible materials. It has been designed for the average user rather than for "stunt" work, and although it has not been thought necessary to introduce any very original features, the motive mechanism and transmission gear are designed to give the maximum of efficiency and long life. The resources and experience of the makers enable them to manufacture practically the whole of the parts, with the exception of the electrical equipment and wheels. In this respect their practice differs from that adopted in most British motor car factories, which are generally confined to the production of certain essential parts, while purchasing from outside firms many of the fittings. Which course is the more profitable is no concern of ours, but for the purchaser there is a feeling of satisfaction in the knowledge that in case of a failure or breakdown there can be no dispute as to responsibility. A detailed description of the car was given in our issue of November 3rd last.

As we noted in our previous reference to the Ruston works, the shops were erected and equipped during the war specially for the purpose of constructing aeroplanes in large quantities, both fuselages and engines, and no pains were spared to make them thoroughly up to date in every department. The plant was therefore readily adaptable, with but few modifications, to the production of motor cars, as will be observed from the illustrations given in a Supplement to-day.

The machine shops alone cover an area of nearly 48,000 square feet, and the tool room 10,800 square feet, the whole being under one roof. All the machines in the first bay have been laid out on the group system; that is to say, they are so arranged that all the component parts upon which a large number of operations has to be performed pass on from one machine to another with the least possible amount of handling. In this bay connecting-rods, crank shafts, cylinder blocks and crank cases are dealt with, all the various operations being carried out with the aid of jigs. At the head of this bay there is the large tool room already referred to, which is equipped with all the necessary appliances for the making of jigs, tools and fixtures so essential for economical and accurate production of motor car parts. No. 2 bay is laid out for milling and grinding operations, and includes a large number of machine tools by the leading makers, capable of working to fine limits. No. 3 bay contains chiefly turret machines and "automatics." In this section of the works all steel stampings, castings and bar work are dealt with, some being put through their initial machining stages, others completely finished, while on others, again, the preliminary machining is performed prior to the heat treating and final grinding processes. We noted in this department the machining work on oil engine fuel atomisers, which requires the highest accuracy. No. 4 bay is laid out chiefly for gear cutting, and in this respect Ruston and Hornsby, Limited, are unsparing in their efforts to produce transmission gears of the utmost accuracy and silence in operation. With this object in view we noted that the spur gear wheels in the transmission system are of the stub tooth type. The timing gears in the engine are of the skew pattern, and the final drive spiral bevel. The method of producing the gears is primarily to finish them off slightly oversize, then submit them to heat treatment and hardening, and finally to take off a slight finish cut. The gears are made of alloy steel. In this department there is also a battery of broaching machines which are utilised for internal splining and keyway cutting as well as for the final "sizing" of the connecting-rod big ends.

The inspection department deals with the material from the rough to the finished product. Here all castings and stampings are carefully scrutinised before being passed to the machining departments to make sure that no time is lost on defective material. During and after machining all the parts undergo further inspection. No. 5 bay is devoted exclusively to sheet metal work, such as wings, tanks, dashes, &c. At the head of this bay is the chassis-fitting section, where the component parts are assembled into units and delivered to the car erectors.

The first stages of car erection are carried out in bay No. 6. Here the frame is put together, and the rear axle mountings are fitted. The engine and gear-box are next dropped into place and the exterior mountings assembled. The chassis is then sent into the test shop. Prior to being mounted in the chassis, however, the engines have all to undergo a prolonged test on the brake. At the head of No. 6 bay is a separate shop for the manufacture of radiators. These are of the so-called "honeycomb" variety, in which strips of brass foil are corrugated and built up into units, which are enclosed in a framework.

Passing out of the main building by way of the sand blast and rough stores, the visitor comes to what is perhaps the most important section of the whole factory, namely, the heat treatment department. Owing to the severe usage which the average motor car has to stand, steels of the highest quality, heat-treated with the greatest accuracy, are necessary, and in this respect the Ruston-Hornsby works will compare favourably with any motor car factory in the kingdom. The heat treatment department is equipped with a large number of gas-heated furnaces of various sizes, provided with pyrometric apparatus whereby the necessary temperatures can be observed.

The motor car body department is contained in a separate building. Here the complete construction of the bodies is carried out. The ash frame parts are all cut carefully to jig from seasoned timber, and then clothed with steel sheeting. The body works embraces a sawmill, framing section, panelling, spray priming, body fitting, paint spraying, filling and rubbing down and upholstering sections. In the body mounting department every part of the car is carefully fitted before the car goes into the finishing shops. The latter form a separate section of the works. A system of spraying paint is employed, and from the priming coat right up to the first coat of varnish fourteen coats of paint are given, after which a final coat of varnish is applied by hand.

The present capacity of the works is about thirty-five complete cars per week.

Air Conference.

No. I.

THE third annual Air Conference held under the auspices of the Air Ministry took place in the Council Chamber of Guildhall, London, on February 6th and 7th. It was preceded by a visit, on February 5th, to the London Terminal Aerodrome, Croydon. A special train conveyed to the aerodrome about two hundred and fifty visitors, who made an inspection of a number of machines and had explained to them the method by which air traffic is now controlled. Although owing to weather conditions the cross-Channel day services were suspended, it was a happy coincidence that Monday night witnessed the carrying out of night flying tests on the London-Paris route preparatory to the inclusion of night journeys in the regular time-table. Much interest was displayed by visitors in the control arrangements, and the organisation of the Civil Aviation Traffic Officer. He is the despot of civil flying, as no machine can leave the aerodrome without his authority. Arrangements are made to show on the large map of the routes traversed the position of any machine at any stage of the journey, a task facilitated, of course, by the maintenance of wireless communication between the aeroplane pilot and the control office. The system is similar to that employed at railway control offices, but owing to the insignificant character of the traffic compared with that of a railway control section, is of very simple form. The Civil Aviation Traffic Officer is also responsible for the night lighting of the aerodrome, the whole of the lights being controlled from the control tower. The accuracy with which the position of machines approaching or leaving the aerodrome can be ascertained was illustrated to visitors by a demonstration of another apparatus, which may be described as an illuminated chart. Once wireless communication has been established between pilot and control office, the pilot can be told his exact position, this being indicated by the automatic lighting of a lamp on the chart of the section within 10 miles radius of the aerodrome. This device is a considerable aid to pilots. In connection with the experiments in night flights which took place on the evening of the visit, wireless telephone messages were exchanged between a passenger on the machine and a Fleet-street newspaper office, when the machine—which had to land at Lympne owing to fog—was approaching Folkestone.

When proceedings opened in Guildhall on February 6th, a formal but cordial welcome was extended to those attending the Conference by the Lord Mayor.

Sir Samuel Hoare (Secretary of State for Air), who occupied the chair at the morning session, said that there were at present two considerable obstacles to the progress of civil aviation. First of all, there was the obstacle caused by the shortage of money, and, secondly, there was the obstacle caused by the after-war confusion of the world. It was indeed a tragedy that just at the moment when we wished to embark upon wide and wise schemes of aviation development, we had on the one hand to cut our national expenditure down to a bare subsistence level, and on the other hand had none of those ample funds that could formerly have been drawn from private capital for enterprise and private adventure. He did not, however, wish to leave the subject at that point, as if the Air Ministry had no policy. He could assure that meeting that so far as he was able, working within obvious limitations, he would try to develop a consistent aviation policy. He had, indeed, been studying for weeks past various schemes which would make for progress, including research work and the maintenance of the British aircraft industry. It would be a calamity not only to civil but to all aviation if the British aircraft industry came to an end. His first act as Secretary of State for Air was to obtain the permission of the Government to go on with the home defence development scheme, which should not only strengthen our air defence but give a stimulus to the industry. Secondly, there was the difficulty of developing and organising civil aviation when the world was still living in an atmosphere of war. What was more important was that as long as we were living in this atmosphere of war and as long as the world was in this state of confusion and uncertainty, military aviation must have the first and principal call upon the nation's purse. Secondly, he had been considering very carefully many schemes for various cross-Channel services. He based his policy on two foundations. First, a sufficiently long period of contract to enable the operating company or companies to sink capital and develop their route. Then there should be as little interference on the part of the Government as was possible under a subsidy system. He wanted to see the operating organisation work out its own salvation and have an incentive to develop along its own lines. Subsidies were only justifiable if after a limited interval they would enable the industry to find its feet. They could not be justified if they only gave outdoor relief to companies but no incentive to develop. Secondly, he was very anxious to see a start made with an Imperial air route, whether it be by aeroplane or by airship. When that start could be made and how, he could not at present say. The decision did not altogether rest with him, for it was a matter for the Cabinet and, indeed, for the Dominions as well. Even to-day the Cairo to Baghdad fortnightly service, which was frankly a military service, carried 28 per cent. of the mail to Baghdad, and the journey, which took two to three days instead of twenty-two days by the ordinary method of travelling, was being performed with great regularity. The Conference which had been inaugurated that morning by the Lord Mayor could do useful work, and most of all, it would be able to instruct public opinion, which was one of the things most needed in connection with air questions.

The reading of papers was then proceeded with, the whole of the first day of the Conference being devoted to the presentation of the five papers included in the agenda.

These papers were: "The Position of Air Transport To-day," by Major-General Sir W. Sefton Brancker; "Establishment of a Self-supporting Airship Service," by Commander C. Dennis Burney; "Progress of Research and Experiment," by Air Vice-Marshal Sir W. Geoffrey Salmond; "Seaplanes," by Mr. C. R. Fairey; and "Gliders and their Value to Aeronautical Progress," by Colonel Alex. Ogilvie.

An abstract of the first-named paper appears below, and of Sir W. G. Salmond's on page 145.

THE POSITION OF AIR TRANSPORT TO-DAY.

General Brancker began his review of the progress of civil aviation during the past twelve months by referring to the International Commission for Air Navigation, as set up under the Treaty of Versailles. The convention establishing the Commission was signed by twenty-one States, but so far it has been ratified by only nine. The Commission meets three times a year. The author described the Commission as being so far a great success, and expressed the hope that it would develop into a strong factor tending towards the maintenance of peace in Europe in the future. Passing on to review the history of air transport during the past year, he described the defects of the old subsidy system in force on the continental services, and the efforts made to remove them by the new non-competitive scheme of subsidisation which was developed in May of last year. Dealing with unsubsidised commercial aviation, he mentioned the de Havilland taxi service and the Savage Sky-writing Company, both of which he stated were making ends meet without financial assistance from the Government, and were providing a valuable nucleus of pilots and machines for emergency purposes. On the question of safety and trustworthiness in commercial aviation, he had an encouraging report to make. During 1922 there were no fatal accidents to passengers on the established British Air routes, and only one slight case of injury. Of the 2055 flights begun on the London-Paris route, 92 per cent. were completed within four hours, as compared with corresponding reliability figures of 89 and 80 per cent. respectively in 1921 and 1920. The increase in the number of passengers carried was, however, disappointing, only 12,365 crossing, as compared with 10,731 and 6383 in the two preceding years. In the central portion of his paper the author dealt at length with the criticisms and suggestions made at the last Air Conference, including those passed by "perhaps the most tiresome critic" of all—himself, General Brancker, when not yet Director of Civil Aviation. He frankly admitted that he could wish himself again this year in the body of the audience, for "there was much in the present situation that he could pick to pieces badly." Dealing with the relations between civil and military aviation, he mentioned that under the auspices of the Government four civilian schools for re-training war-time pilots were being established at the works of certain leading aircraft manufacturers, and that a scheme was almost ready for granting a bonus on approved aero engines.

Speaking of future developments he made the following remarks:—

To-day it has been proved practically that the D.H. 34 type, carrying eight passengers and baggage, or 1800 lb. of useful load at 100 miles an hour, on a service running twice a day each way between London and Paris, should cost at the most 4s. 6d. a mile to run, this sum covering all administrative costs and overhead charges as well as running costs. If heavy traffic can be obtained, these costs at once drop. With eight services a day each way between London and Paris, the mileage cost for the eight-passenger machine can be reduced to about 3s. a mile, so that if you could get about sixty passengers a day each way, you could carry them at £4 8s. a head, or at £5 with a considerable profit, without any subsidy.

This is purely a question of good organisation and obtaining traffic. As regards organisation, we are learning every day, and we are very distinctly better than we were a year ago. The great secret of this organisation is to ensure that every unit of the air service—the aircraft, the engines, pilots and mechanics—is doing the maximum amount of work of which it is capable. Even a small fleet of three aircraft, nine engines, and ten pilots could make over 2500 trips between London and Paris during the year. Having got this fleet properly organised, it is then a question of obtaining sufficient traffic to justify this amount of flying. If you take this figure—2500 trips—and confine yourselves to passengers as a basis for argument, if these machines were eight-seaters, we should have to carry 15,000 passengers in the year in order to ensure a three-quarter load. Well! only 12,000 all told were carried across the Channel during 1922, so actually to-day the traffic in passengers across the Channel is insufficient to give really full work to a fleet of three single-engine aeroplanes. So we come down to the bedrock fact that we must increase the traffic if we are going to make air transport a success, and in a way our greatest problem to-day is how are we going to induce the public to use air transport? First, it is obvious that we must give them some advantages over other means of transport; the great advantage that aviation can claim is speed; we must, therefore, fly far enough and fast enough to give air transport a definite advantage in time over other means of progression. Having organised routes which give this advantage, it is next absolutely necessary to prove the safety and reliability of air transport. The public will not use air transport so long as they are afraid of being hurt or killed themselves or of serious delays occurring on route. In addition, the prices charged for travelling and despatching goods by air transport must be sufficiently low to attract traffic. Now, unfortunately, safety and reliability are not cheap, so that, whilst safety and reliability are being established in order to attract traffic, the high rates will prevent this traffic coming if the service has to pay its way. It is this fact that makes it necessary for Government to step in with financial aid. It should be realised that this financial aid is being given to enable air transport companies to charge reasonable rates and run at a loss during the period necessary to establish the safety and reliability of air transport, and so attract sufficient traffic to enable low rates to be charged without Government assistance. This we are doing at present, and I have already tried to indicate to you the various lines upon which we are progressing.

Now, to turn to the technical side, which has really nothing to do with traffic or with organisation. In an ordinary cross-Channel service to-day we find that three outstanding items of expenditure are the cost of maintenance of the engines, the cost of fuel, and the cost of insurance. There are others, of course, but these are some of the greatest, and I will take them as examples of how expenditure will be cut down in the future.

The air engine of to-day is absurdly fragile; it needs constant attention and a great many spare parts to keep it running reliably, and probably at the most it can run only 200 hours without overhaul, which means it may have to undergo four or five complete overhauls at very considerable expense every year. Now, this is the result of the fact that every engine we are using to-day has been developed for purposes of war, and we have not yet had time, nor spent the money necessary to produce a really economical and commercial engine. I am convinced that this can be done without sacrificing very much weight. An air engine runs in the most ideal conditions—no dust, no vibration, no clutches, no brakes—just easy, smooth running in an ideal cooling medium. I can see no reason why engines should not be constructed which could run without overhaul for 600 hours or for 1000 hours, and when these engines are produced we shall reduce our maintenance costs by about 75 per cent.

The cost of fuel is a very big item, but already we are well within reach of using heavy oil instead of petrol without any appreciable increase of weight. For a journey of four or five hours, when this is obtained, we shall at once save something like 70-80 per cent. on our fuel bills.

Insurance is partly affected by the volume of traffic, partly by technical considerations. I have already indicated that we must be patient regarding the traffic, and Government must help during the time our custom is built up. An increase of traffic will increase the business of the insurance underwriters, who will at once lower their premiums. From the technical point of view, premiums are high to-day, chiefly on account of the danger of an engine failure and consequent damage to the aircraft. They are not high for the insurance of goods, passengers or crews, because the insurance underwriters realise that the risk there is actually very small. It is the expense of repairing aircraft against which they have to insure. With a perfectly reliable engine, which I believe must come, insurance rates will certainly drop, and I can see no reason why they should not be reduced at least 50 per cent. In fact, to-day, already, in the case of one company which has been particularly free from breakages, this reduction has actually come about.

These three big items in an estimate which I have here, of the expenses of a company running several services, amount to £131,000 out of a total annual expenditure of £264,000. By means of the steps in progress I have just enumerated, this item of £131,000 can be reduced to £35,000, and our total of £264,000 annually expended drops at once to £168,000.

There are other technical items which will save money in maintenance, such as metal propellers, all metal construction, &c. &c. Again, there are other items of technical development which will not reduce the costs of running the service, but will increase our carrying capacity per horse-power. First, metal construction is promising very well indeed, and it appears almost certain that considerable weight will be saved by all-steel construction, as compared to the present wood construction. I believe there have been planes designed and approved already which show an actual saving of 20 per cent. in structural weight. I am not a scientific expert, but I believe that if 20 per cent. is saved on the structural weight of an aeroplane, that aeroplane will at once have an increase of about 7 per cent. in its paying load for the same horse-power. Secondly, it is uneconomical to use exactly the same engine and propeller to get off the ground as for flying at cruising speed. The limiting factor in the carrying capacity of any aircraft to-day is the amount of weight which can be lifted safely from the ground with the engine all out; once the machine is well up in the air, the engine is throttled back, and this load is carried quite easily; in fact, a considerably greater load could be carried if it were not for the difficulty of getting off. Experiments are now in progress towards obtaining a variable pitch propeller or a two-gear engine by which a considerably increased weight could be lifted off the ground with the same horse-power. Again, slotted wings and variable cambered wings are being devised by which greater lift can be obtained when getting off and landing, which again means a greater load can be lifted from the ground for the same horse-power.

Assuming that some of these experiments are successful, I see no reason why the useful load of an aeroplane of given horse-power should not be increased by about 20 per cent. of what it is to day without any increase of horse-power. So once more I repeat the statement that I made originally; I believe that in a very few years we shall be carrying ten passengers, or their equivalent weight, at 100 miles per hour, for about 2s. a mile, which surely is a commercial proposition. I think that is enough of the financial side of air transport.

Comfort is being improved. We shall have comparative silence before very long. Experiments are in progress in heating and ventilating the cabins, of which we know little at present. I hope this may tend to eliminate air sickness, the exact causes of which are still unknown.

Personally, I contend that the air is the most comfortable means of transport to-day for those who like; in five years' time, I think, no one will be able to deny its superiority.

As soon as its reliability is established all mails will inevitably be transported by air, and the pounds of letter carried to-day will be converted into tons. These are only the possibilities of to-morrow.

I will not waste your time by wandering into the wonderful realms of the more distant future.

I will only say that heights of 30,000ft. and speeds of 300 miles an hour are possible—placing New York within twelve hours of London; that navigation through any cloud or storm will be as easy to the aircraft of the future as navigation of the sea is to the big ship of to-day—and to the sceptical I only say, "Compare the latest commercial air liner of to-day with the 50 horse-power box-kite of 1912—and think."

At the opening session on February 7th, the Duke of Sutherland (Under-Secretary of State for Air) occupied the chair, and a discussion took place on the papers by Sir Sefton Brancker and Commander Burney.

Mr. Holt Thomas believed he could give the Air Ministry an assurance that the country would welcome any step taken to advance aviation. He was not, as some people appeared to think, opposed to Commander Burney's airship scheme, as he did not see how the Navy could do without airships. He did, however, question whether there were any reliable figures to show the probable cost of operation of airship services. General Brancker had given an interesting account of the progress made during the past year, but he hoped the work of the Conference would not be confined to a record of achievement. The idea behind those who convened those gatherings was that they were not for experts but to interest the business men of the City of London in the subject and to call the attention of the Government of the day to things which ought to be done. Whatever the condition of affairs in connection with finance or politics might be, they need not prevent the evolution of a practical air policy. Everybody knew that flight from London to India and Australia was only a question of money. An attempt ought to be made to show what civil aviation could do for British industry. At the present time too much attention was paid to passenger traffic; consideration should be given to air transport for the handling of freight, and for other requirements. As General Brancker had told them, the London-Paris services had been a disappointment. The opening up of routes which were of interest to the British Empire was a sounder policy. The United States Government had taken the practical course of utilising air transport for mails and for the general improvement of communication. The proper function of air transport as far as Great Britain was concerned was the opening up of rapid communication with the outlying parts of the Empire. There must be hundreds of firms engaged in Indian and Australian trade which would make use of air transport for urgent traffic, and that was an aspect of the question which ought to interest the business man in the City of London. The speaker concluded by moving the following resolution: "That in view of the need of increased rapidity of communication within the Empire, and of the progress made by other countries in civil aviation, this Conference calls upon the Government to give immediate consideration to the foundation of air mail services throughout the Empire."

Admiral Mark Kerr seconded the resolution. He said his own view of the new air services was that they should be confined to the carrying of freight until they were made to pay. If the Government would open up routes for the carriage of mails these services could be made self-supporting after a certain time.

The resolution was then put to the meeting, and carried.

Lord Gorell, resuming the general discussion, said that Commander Burney's paper was more than anything else an attempt to demonstrate the superiority of aircraft over seacraft. It had never been stated quite so definitely that sixteen airships could be constructed for the price of one battleship, nor that nine airships could do the work of sixty cruisers and save over £50,000,000. Statements of this kind coming from a sailor were somewhat arresting. In the attempt to launch his scheme, he noted that Commander Burney ignored the Air Ministry, and gave preference to the Admiralty. The arguments put forward appeared to set up a rivalry between the airship and the aeroplane, which was to be regretted. He would point out that an airship scheme which, it was admitted, could not be launched without Government aid, could hardly be regarded as self-supporting. It appeared to him that, having regard to the limited amount of money available for air transport, and the costly character of airship services, a case could be made out for spending what money could be allocated for aviation on the development of heavier-than-air machines. With regard to General Brancker's paper, it gave an account of definite progress, and he hoped that what had been referred to as a temporary scheme in connection with European services—to Paris, Cologne and Berlin—would emerge into a definite permanent scheme. Those routes were, until Atlantic flight was possible, the main arteries along which air traffic from England would flow. He agreed as to the undesirability of laying too much stress on passenger traffic, believing that efforts should be concentrated on the transport of mails and goods. He would like to know why it was not possible for the British Post Office to follow the example of the United States postal authorities and send mails by the quickest mode of transport available without any extra charge to the public. In conclusion, having in mind the changes which had taken place in the *personnel* of the Air Ministry, he would suggest that it was one of the departments of State which should be outside the sphere of party politics.

Mr. Handley Page referred to the progress made with air services in Australia as well as in Europe. It was the duty of Great Britain to see that the gap between home and Dominion air services was bridged. On the subject of the safety of air travel, he was able to state that his own company had made no claim against insurance companies for a period of two years for accidents to machines. He could not agree that passenger traffic should give place to the carriage of goods. A higher rate could always be obtained for the carriage of passengers, and it was the most paying load. In connection with the campaign for the improvement of air transport, he would desire to lay stress on the importance of allocating funds for research work.

Major-General Seely questioned the wisdom of economies in national expenditure which would have the effect of starving aviation either on the civil or military side. If he were asked what would prove of the greatest assistance to civil aviation apart from Government aid, he would plead for the elimination of noise when the machine was travelling in the air. It was not only a question of the effect on the passenger, but of the effect on the pilot. A difficulty in air travel was that the brain of the pilot could not be made to do more than a certain number of things at the same time. There was a tendency to add to the number of gadgets in aircraft, and it could not be doubted that the elimination of noise would increase the efficiency of every pilot. He was glad to know that the problem was receiving attention and that encouraging progress was being made.

Mr. A. H. Ashbolt (Agent-General for Tasmania) raised the question of Imperial communications. Unfortunately, he said, the realisation of any scheme of that character was apparently no nearer than it was a year ago. The only crumb of comfort was that the airship establishments had not been completely broken up, and he hoped that the dispersal of our airship assets would be deferred until a definite decision was reached with regard to the proposals of Commander Burney. The delay in the issue of the report of the Amery Committee on the subject of Imperial communications was somewhat inexplicable, particularly as the voice of rumour indicated that the report favoured the establishment of Empire airship services. Speaking as a representative of one of the Overseas Dominions, he felt that they had not been quite fairly treated in this matter. In the interest of Empire trade, and quite irrespective of the naval aspect, he asked that the Committee's report should be issued without further delay. It was realised that nothing but a practical experiment such as was suggested by Commander Burney could demonstrate the possibility of those airship services. It would seem that Service jealousies between the Admiralty and the Air Ministry had been partly at least responsible for the delay in reaching a decision on Empire air services.

Sir Alan Anderson, speaking as a shipowner, commented on the value of the development of commercial aviation. The nation which took the lead in commerce would always be prepared for war. The same question had arisen in connection with sea power. Turning to Commander Burney's scheme for Empire services, the method proposed had great possibilities. The speed of travel in comparison with the high-speed steamship was an asset of tremendous importance. The great need of the time was to bring about a trade revival, and if by the use of air transport it was possible to effect an appreciable reduction of time in communication with distant parts of the Dominions, an important service would have been rendered to the Empire as a whole. He would like to see the possibilities of airship services made the subject of a practical experiment, and if the safety of the airship could be demonstrated, many people would, he was sure, travel by air over long distances.

Captain Instone commented on the fact that the Conference was always held at the fag end of a subsidy period. The temporary character of the subsidy was a disadvantage not only from the operating but from the manufacturing standpoint. Nobody knew how long the thing would last. Research and experiment and practical testing under service conditions of the different types of machine were needed. The real commercial aeroplane had not yet been evolved. It was not possible to get an aeroplane to-day that would pay for its keep. With regard to the international position, things were more satisfactory; but it would be desirable if the same facilities which were given to foreign lines at Croydon were available to British companies operating continental services. He hoped that Germany would join the International Convention and simplify flying arrangements in regard to that country. On the subject of safety in air travel, he could confirm what had been said by Mr. Handley Page. His own line had had no fatal accident since it started.

Admiral Mark Kerr said that the references made to commercial aviation suggested that it was only being developed for the benefit of trade. It would be of advantage to trade, but it must not be forgotten that commercial aviation would be the great backing of the air power of the Empire. We had not got command of the air, and it was the duty of the Government to back civil aviation with that object in view. In naval affairs speed and range were the factors which counted, and the battleship had been rendered obsolete. The Government had decided to spend £16,000,000 on two new capital ships. His comment on that decision was that £10,000,000 of that sum would make us safe in the air. A strong, prosperous civil aviation industry would supply the reserves of factories, pilots, and skilled mechanics to assure our supremacy in the air. The country must be frightened into a belief that the air was the element of which England must have command, and the public would then frighten the Government into taking action. To secure absolute safety in the air he advocated the fitting of every service machine with a parachute.

Colonel Williamson (Post Office) said that from the postal standpoint 1922 had been a disappointing year. His own view was that as long as the air services were only over short routes they were of comparatively little use for the carriage of mails. The most useful development of the past year had been the air parcels post to Paris, which had been a decided success. The most important air mails were those between Cairo and Baghdad, which, in the December quarter of 1922 showed a traffic increase of 600 per cent. over the corresponding period of 1921. The gain in time on that route was, of course, quite exceptional. Reference had been made by Lord Gorell to what was being done in the United States, but that was a country of great distances, where the gain in time by the use of air transport for mails was considerable. The experience of the British Post Office last year confirmed the earlier impression that until the aeroplane services available were extended in point of distance they were of little use for the carriage of mails.

Sir Henry White Smith agreed with Captain Instone's criticism that a commercial aeroplane was not yet available. That fact emphasised the need of giving renewed attention to research work, and money thus expended would be repaid over and over again by the economy which would result from the use of improved types of machines. He did not even yet know what were the qualities required in a commercial aeroplane. Questions of the most suitable size and speed were still undetermined. It was desirable that research on the evolution of the best types of commercial aeroplane should be regarded as foundation work at the present time.

Commander Burney explained that he had preferred to deal with the Admiralty only because the Air Ministry had no funds to spare, and the Admiralty had money. The last-named Department was also that which was responsible for securing the safety of the ocean trade routes.

General Brancker, in a brief reply to some of the points raised, said he agreed that the London-Paris service was not suitable for building up a large traffic, but that service would be extended to more distant points. The temporary character of the subsidy scheme could not be helped. The explanation was that the £600,000 voted for the purpose was now nearly exhausted, and the whole question had to be reconsidered. With regard to research work, his department intended to call for tenders for three machines, and to make an effort by experimenting with them to arrive at designs for commercial types of aeroplanes. Those machines would have features incorporated to make them suitable respectively for European and Indian service, while the third would be for a long-distance flight, *e.g.*, London to Malta. Reference had been made to parachutes. Their use was rather for military than commercial machines, for which the only suitable type of parachute would be one capable of taking pilot and all passengers safely to earth in the event of accident.

NEGOTIATIONS are under way which are expected to lead to the establishment of an important industry in Southern Alaska capable of furnishing perpetually a large proportion of the print paper demands of the United States. The Secretary of the Department of Agriculture expects soon to sign contracts with a number of responsible concerns for the purchase of pulpwood from the Alaska National Forests, and for the allocation of water power sites through the Federal Power Commission, for the purpose of manufacturing both pulpwood and paper. In the Tongass National Forest it is estimated that there is a source of supply of timber which can furnish perpetually an annual yield of print paper equal to one-third of the total national consumption of the United States. The industry when established will be upon a permanent basis, with raw material at a reasonable price. For some time the forest service has been collecting the information essential to the practical development of the Tongass National Forest, and the work is well toward completion. The merchantable timber in that forest includes at least 100,000,000 cords of western hemlock and Sitka spruce. As a step toward the establishment of the paper industry in Alaska the Tongass Forest has been tentatively divided into fourteen zones, each embracing sufficient timber to furnish a large paper mill with a permanent supply of raw material. Each zone has been delineated, so as to include water power sites sufficient to meet the requirements of manufacture.

A Seven-Day Journal.

The New Element.

THE new element—hafnium, as it has been provisionally called—has been isolated. It was only a fortnight ago that we recorded its detection by MM. Coster and Hevesy, of Copenhagen. Yet on Thursday of last week Dr. Alexander Scott, Director of Science at the British Museum, laid before the Chemical Society a dark cinnamon-coloured powder which he stated was an oxide of hafnium. Dr. Scott, we understand, has been carrying out research work on the subject for some time, and no doubt had the announcement from Copenhagen been delayed for quite a short time, the honour of having first detected indisputable indications of the element, as well as isolating it, would have fallen to British science. Dr. Scott obtained his sample, it is interesting to note, from New Zealand black sand, consisting in the main of a mixture of the oxides of iron and titanium. We are not certain whether the black sand in question is the familiar New Zealand material of that description or a special form of it, but at any rate the deposit from which it was derived is said to be sufficient to give a large yield. As for the possible use of the new metal, it is, of course, much too soon to begin talking. Dr. Scott has suggested that it might be found suitable for incandescent lamp filaments and for the manufacture of crucibles.

The Alleged Dangers of Gas Poisoning.

DEALING with the allegations regarding gas poisoning by virtue of the increased percentage of carbon monoxide now being supplied to consumers, Mr. Watson, chairman of the Gas Light and Coke Company, at a meeting of the proprietors last Friday, made a comparison between the risks run in this respect and those incurred from other adjuncts of our modern civilisation. Deaths resulting from gas, he said, amounted to about 2½ per million of the population per annum, exclusive of cases of suicide. On the railways, accidents resulted in an annual loss of 22 lives per million of the population; while street accidents in London caused 100 fatalities on the same basis. Even coal fires were, he said, much more dangerous than gas, for in 1919 992 inquests were held on children under five who had been fatally burned with domestic coal fires—excluding conflagrations. Mr. Watson's argument would perhaps have been strengthened if he had included in it particulars as to fatalities incurred by electric supplies, for behind both the agitation against the therm system and the outcry against carbon monoxide poisoning there is suspected by many to lie the not altogether disinterested encouragement of the electric light companies. As for the exact figures quoted by Mr. Watson, we repeat them without assuming any responsibility for their accuracy. Indeed, they seem in some respects to be open to criticism. The railway accident fatality figure, for instance, seems to be exaggerated. In 1920 the total number of passengers and servants killed in railway accidents or by the movement of railway vehicles was 382, or about 8.5 per million of the population, as compared with Mr. Watson's figure of 22. Even this reduced figure is not comparable with the 2½ per million rate for gas poisoning, unless the latter includes—and we are by no means certain that it does—accidents both to consumers and to the gas companies' servants at the works or elsewhere.

The Stability of Passenger Ships.

IT is of interest to learn that the "bulges" which were used during the war as a means of underwater protection for warships against mines and torpedoes, are now being fitted to passenger ships by German shipbuilders as a means for increasing stability and compensating for heavy superstructure. The first large vessel of this type to be built is the Albert Ballin, a 620ft. passenger and cargo vessel, which was recently launched from the Hamburg yard of Blohm and Voss, and which, along with her sister ship the Deutschland, will enter the service of the Hamburg-Amerika Line during the present year. The normal breadth of the ship is about 72ft., and the breadth over the bulges 78ft. A part of the bulge space on either side of the ship will be used as an anti-rolling tank constructed according to Dr. Frahm's latest patent, whereby all interior tank connections are done away with. The rest of the bulge spaces may be used for oil fuel and ballast tanks, and the number of special tanks required in the ship are thus reduced, with a corresponding gain in cargo space.

Standardised Aeronautical Terms.

THE growth of science inevitably calls forth a new jargon with each development, but some time has always to elapse before the various colloquialisms and semi-slang terms become sufficiently widely accepted to reach the dignity of established phraseology. In the case of aeronautics, the phraseology in use is peculiarly rich in colloquialisms, and affords a wide field for standardisation. In 1909 the Royal Aeronautical Society began such work, and in 1919 published a glossary of aeronautical terms. That glossary has now been revised and issued as the "British Standard Glossary of Aeronautical Terms" by the British Engineering Standards Association. The work of compilation has been assisted by the Air Ministry, the Patent Office, the Aeronautical Research Committee, the Royal Aeronautical Society, the Royal Aero Club, and the Society of British Aircraft Constructors. The glossary is something more than its name indicates. It is more a dictionary than anything else, and is liberally illustrated with explanatory diagrams and half-tone engravings. It covers aerodynamics, airships, aeroplanes, aero-engines, air screws, instruments, armament, meteorology, and timber nomenclature. For the price charged—1s. net—it is a remarkably good investment for all interested in aeronautics. It is issued none too soon, for there is a distinct tendency to adopt words of foreign origin among aeronautical people. An example of this tendency was to be found in Sir Geoffrey Salmond's Air Conference paper dealing with the progress of research—a summary of which is reprinted elsewhere. In a revised copy of this paper sent to us by the Air Ministry, we notice the consistent use of the term "airplane," an Americanism which we are glad to notice the glossary refuses to recognise.

The British Empire Exhibition Report.

THE report prepared by Sir William Joynson-Hicks on certain questions affecting the organisation of the forthcoming British Empire Exhibition was issued on Monday. It contains little of direct interest to engineers, except in so far as their position as exhibitors would be affected by the general success or otherwise of the undertaking. It is therefore satisfactory to note that all causes of complaint on the part of the Dominions as to the use of Empire products have now been removed, and that in connection with the amusements concession, "the veiled suggestions of corruption," to quote Sir William's words, have been found to be without justification. In general, the report recommends that no change should be made at this late hour in the general management, but that control over it should be very greatly strengthened by the appointment of a standing executive committee of five members to control and supervise the management in place of the existing unwieldy executive committee of over 120 members. Sir William concludes his report by stating that he has received clear indications of undercurrents on both sides of personal animus and trivial criticism, and by warning all concerned that any farther trouble may be fatal to the success of the Exhibition.

Gasworks Development in Manchester.

THE reconstruction of the Bradford-road Gasworks of the Manchester Corporation, which was begun in 1914, but was interrupted by the war, has now been completed at a cost of about £800,000. The works have now a producing capacity of 16 million cubic feet of coal gas and 6 million cubic feet of carburetted water gas per day. The completion of the scheme allows the water gas plant to be used for meeting the exceptional demands caused by fog and prolonged dull periods. The Gaythorne and Rochdale-road works have only a daily output of 5 million cubic feet, compared with the total 22 million cubic feet of the Bradford-road station. Retorts of the latest horizontal and vertical types are installed, and all auxiliary and conveying plant is of the newest form. Careful records of the working costs of the various methods of carbonisation are being made, with a view to maturing the plans for a super gas station at Partington on the Ship Canal. A report on the proposed Partington scheme for a 40 million cubic feet installation, costing £900,000, was submitted to the Manchester City Council on Wednesday last.

Thompson Memorial Lecture.

ON Thursday last Sir Oliver Lodge delivered the first of a series of annual lectures by which the old students of Finsbury Technical College propose to keep green the memory of Silvanus P. Thompson, who for many years devoted himself to that College. The lecture was delivered in a very big hall or chapel in the institution adjoining the Finsbury Technical College, before a crowded audience. Sir Oliver opened his address with a brief appreciation of Silvanus Thompson, whom he lauded for his industry and for a breadth of view that made him, at once, a scientist, a linguist, and an artist of no mean order. He formed one of that group of four illustrious men—Ayrton, Perry, Meldola, and Thompson—who by their ability, foresight and personality had put Finsbury Technical College in the highest rank as a teaching institution. He was glad indeed to think that the College had been saved from destruction, and he hoped it would never again be threatened. Turning then to the nominal subject of his address, he dealt briefly with the history of wireless telegraphy up to 1896, when Marconi raised it from the laboratory to every-day uses. An interesting characteristic of the lecture was the frequency of parenthetical notes, mainly about the ether, which he implored his hearers to believe in, and not to trust the relativitists who merely dispensed with the ether by ignoring it. The Old Students' Association is to be very heartily congratulated upon the great success of the first Thompson Lecture.

Ship Repairing Developments.

IT is announced that Swan, Hunter and Wigham Richardson, Limited, have become associated with the New York Dry Dock Company, of Clifton, Staten Island, New York, and that an arrangement has been made whereby British shipping may be repaired in the United States instead of deferring repairs until arrival in home ports. The two floating docks belonging to the American company, of 12,000 and 8000 tons capacity, are admirably placed in a sheltered position near the entrance to New York Harbour, and in winter the Staten Island shore is generally free from ice. We learn that the American company has a British representative at the London office of Swan, Hunter and Wigham Richardson, Limited, at 21, Russell-square, W.C. The ship-repairing yards of Harland and Wolff on the Thames at King George V. Dock are expected to be completed by about the middle of the year, and a large floating dock for the Thames is now under construction at the firm's Govan yard. The dock, when completed, will be stationed at the Norway Dock in the Surrey Commercial system. The repair shops will be equipped with the newest machinery, and special provision has been made for large Diesel engine repairs.

The Late Mr. Arthur Mechan.

IT is with regret that we have to chronicle the death of Mr. Arthur Mechan at Largs, Ayrshire, last week. Mr. Mechan was in his ninetieth year, and was the founder and for many years the head of the well-known Clyde firm of Mechans, Limited. The business now carried on at Scotstoun Ironworks was established by him at Cranstounhill in 1862. Trained as a mechanic, Mr. Mechan had a wide experience of general engineering and steel works contracting, and he was actively associated with the business up till his retirement about thirty years ago. Since that time he travelled widely, remaining in close touch with industrial and public affairs, and until very recently he was a frequent visitor at the Scotstoun works. Mr. Mechan was one of the pioneers in the development of Clyde industry, and could recall many interesting stories and personal reminiscences of the early days of engineering and shipbuilding.

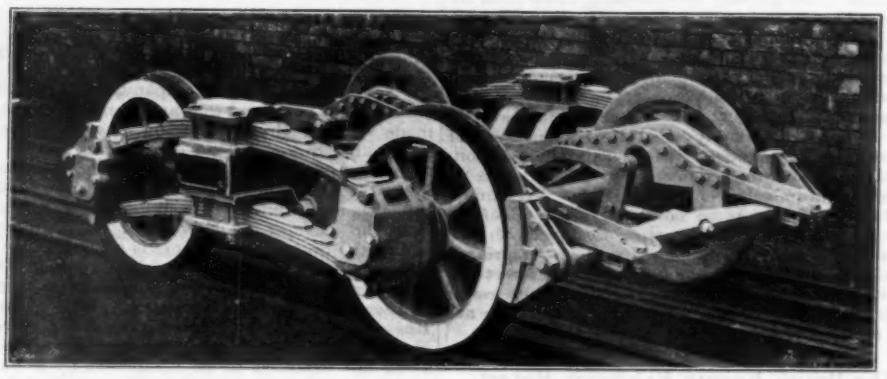
Sixty Years Ago.

IN our issue of February 6th, 1863, a paragraph appeared recording that M. Mongruel, a French inventor, had devised a new form of illuminating gas which would "free us from the tyranny of the gas companies and the dangers of gas and provide a light at once infinitely cheaper and more efficient." The process consisted of passing air through "photogene," a liquid which we surmised to be "a naphtha of a highly volatile description." In another paragraph it was reported that Mr. John Penn, of Greenwich, and Mr. William Pole, F.R.S., had joined the War Office Committee appointed to inquire afresh into the relative merits of Sir William Armstrong's and Mr. Whitworth's systems of gunnery. The experiments designed to settle "the great gun controversy" were not likely to begin before the middle of March, for the huge target made for the purpose had not yet left the works of the Thames Iron Company. A long account was given of a legal action "of rare magnitude and importance," in which Mr. John Clare, formerly a produce broker of Liverpool, sought to recover payments by way of royalties and damages for infringement of his patents from the Admiralty in connection with the construction of H.M.S. Warrior and other naval ironclads. Inspired by the loss of the Birkenhead in 1847, the plaintiff had developed and patented a system of constructing iron ships, the noteworthy features of which were the inclusion of a longitudinal and vertical framework of iron and a double iron skin with wood packing. He claimed by way of compensation 5 per cent. on the shipbuilding outlay for the preceding and ensuing seven years, appointment as Naval and Mechanical Constructor to the Navy, authority to build a 20-knot steam vessel at a cost of £500,000 and a commission of £25,000, and the placing at his disposal of a shipyard and ironworks in order that he might construct a vessel in accordance with his plans. The evidence and cross-examination traversed a great deal of the history of iron shipbuilding. Chief technical evidence against the patent was supplied by Mr. Carpmael, who was in the witness box continuously for more than five hours. The case ended completely in favour of the Crown,

New Rolling Stock for the London Tube Railways.

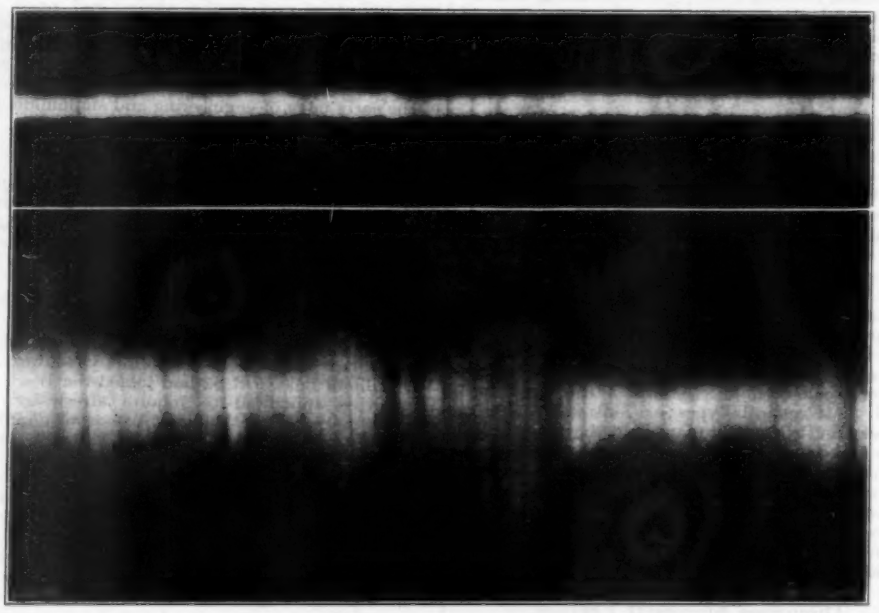
ON Saturday last a special trial run was made on the "Underground" of some new coaches which have been built with the object of discovering the ideal type of rolling stock for the London electric tube railways. The coaches were made up into two trains, three coaches in each train, and are illustrated by the views on page 148.

The orders for these coaches were placed last August. One vehicle was to be supplied by each of the following firms:—The Birmingham Railway Carriage and Wagon Company, Limited, of Smethwick; Cammell Laird and Co., Limited, of Nottingham; the Gloucester Railway Carriage and Wagon Company, Limited, of Gloucester; the Leeds Forge Company, Limited, of Westminster; and the Metropolitan Carriage, Wagon and Finance Company, Limited, of Birmingham. An additional order was also placed with the Gloucester company to build a car to a design prepared by the Underground Company. Our illustrations do not include an interior view of this car, but we give a view of one of the standard existing coaches for comparison with the new vehicles.



THE GIBBINS RAILWAY BOGIE

In giving out the orders the railway company left the design very much to the discretion of the builders, but naturally made a few reservations, such, for instance, as the width and position of the doors, while it was stipulated that the cars should be made as silent in running as possible. The extent to which the latter requirement has been met may be judged by the two photographs of "sounds," which we reproduce. They were taken by Dr. Low with the instrument we recently described. See THE ENGINEER, September 29th, 1922. The lower



AUDIOMETER RECORDS FROM NEW AND OLD CARS

engraving shows the broad band of light reflected from the mirror disturbed by the loud sound waves of the old rolling stock, while the upper view plainly indicates the quieter running of the new coaches. The improvements effected in this direction really need no instrument for their demonstration, and the noise has been reduced to such an extent that we had no difficulty, during the trial runs, in carrying on a conversation with passengers sitting on the opposite seats.

It is not, of course, possible yet to say which of the several coaches will prove most successful in meeting the requirements, and it is not unlikely that certain features of each vehicle will be incorporated to produce the new standard for adoption when the orders are given for the rolling stock required by the extensions of the railways now in course of construction.

The following are the principal features of these new cars, all of which seat forty-eight passengers, with the exception of the control trailer, designed by the railway company, which seats forty-four passengers:—

Car No. 823: *The Birmingham Carriage and Wagon Company.*—Interior decoration, grey; all fittings have oxidised silver finish; all the windows are made to open, and are fitted with frameless sashes; leather straps.

Car No. 824: *Cammell Laird Company.*—Interior decoration, blue and gold finish; aluminium fittings; concealed lighting with additional lamps in the clerestory; special ventilation in the clerestory.

Car No. 820: *The Gloucester Railway Carriage and Wagon Company.*—Interior decoration, blue and grey with light stone coloured roof; pendant lights down the centre of the car, with side bracket lamps at passengers' backs; leather straps with wooden lining; additional side and end ventilation.

Car No. 821.: *The Leeds Forge Company.*—Interior decoration, green and brown; aluminium fittings; straps with sockets suspended from the roof; lighting by fittings in bulk overhead.

Car No. 822: *The Metropolitan Carriage and Wagon Company.*—Interior decoration, blue upholstery with mahogany and maple panelling; canvas rubber straps; the panelling used consists of aluminium alloy in order to lighten car; special rubber preparation for flooring.

Car No. 720: *Underground Company's design (constructed by the Gloucester Carriage and Wagon Company).*—Interior decoration, brown with white panelling and ceiling; lighting entirely by side brackets; leather covered arm rests; fittings in oxidised copper.

All the car bodies are of steel. One of the builders has even suggested that high-tensile steel might be used in the future in order to lighten the structure, and estimates that a saving of some 10 cwt. might thus be effected in the weight.

A distinct innovation has been made in the case of the Gloucester company's coach in using the Gibbins type of bogie. The Gibbins bogie, of which we give an illustration, has been found very satisfactory for service in Rhodesia, and, as will be seen from the engraving, exhibits a radical departure from orthodox practice. There are no side frames, and the springs transmit the load directly from the bogie bolster to the axle boxes. Among the advantages claimed for the arrangement, one of the most important is smooth starting and stopping, which is naturally accounted for by the absence of clearance, or backlash, between the axle boxes and bolster.

THE central station in Milan was badly damaged by fire on the 30th ult. Plans were, some time ago, approved for a new station, and perhaps the present disaster may lead to the work being put in hand. The new station will be of the end-on type and not a through station as now.

The Spinning Mule.

THE third and last of the papers dealing with textile machinery, which has been arranged by the Committee of the North-Western Branch of the Institution of Mechanical Engineers, was read on Thursday, 1st inst., by Mr. J. Hardman, Bolton, Mr. A. Saxon being in the chair. The author confined his paper mainly to a consideration of the principal parts and motions of the mule, and described the mechanical features. He claimed that the mule was one of the most wonderful pieces of mechanism ever invented, and so delicate and accurate in its operations, that 1 lb. of cotton could be spun into yarn 200 miles long. With the aid of admirable illustrations, Mr. Hardman dealt with the many pieces of intricate appliances, and made special reference to the spindle. He said it was a fine example of precision work, completed in twenty-five operations, capable of revolving at 10,000 revolutions per minute without vibration, and yet could be sold for fourteen pence. With regard to the driving of mules, the author presented a power diagram of a short experimental mule, the prominent feature of the diagram being the "peak load," which exceeds 20 horse-power for an instant. That demand for power the author attributed to the inertia of the rim shaft, carriage, tin rollers, and spindles which have to be started from rest to full speed in about 1½ sec. It was that peak load which had made individual motor drive for mules not nearly so satisfactory as other individual motor drives in the mill. Obviously the motor must be made large enough to withstand the constantly recurring peak load, or burning out and other electrical troubles would result. In the first place, the initial cost would be high and the efficiency low; and, secondly, the risk of stoppages due to breakdowns in the power unit would be great. The electrical engineer was, therefore, faced with the problem of designing a motor capable of a power output equal to about three to four times its normal rating, and that "peak demand" had to be met three to five times per minute. On a full size mule the "peak" load might reach 50-60 horse-power.

An interesting discussion followed the reading of the paper, in which Messrs. Berry, Rhodes, Richardson, Dempster Smith, Hill and the chairman took part. In reply to the points raised, Mr. Hardman said, in answer to Mr. Berry's question respecting the stretching of new scroll bands, that it was always a source of trouble. The operative had to pay constant and careful attention to new bands until they ceased to give trouble. Although cotton ropes were most generally used, wire ropes had been tried, and at the mill of Thos. Oliver, Limited, chains were being used. He thought it hardly possible to make a fair comparison of the production of the mule and ring frames. On coarser counts the ring frame had a certain advantage, but on the finer counts the mule frame was the better, and beyond a certain point only the mule frame could be used. Furthermore, a much better and more regular yarn could be obtained on the mule frame. As far as could be seen, the mule would never be superseded by the ring frame for the higher qualities of work. With regard to the use of a lighter metal for the carriages, raised by Mr. Richardson, Mr. Hardman stated that it was not the weight of the carriage, but the inertia of the spindles in starting up to get the maximum speed that absorbed the power. So far as he was aware, lighter metals, such as aluminium, had not been tried. In reply to Mr. Smith's question regarding the accuracy of the spindle, Mr. Hardman stated that the accuracy referred to was in the finish. The spindle was ground to certain dimensions, but the accuracy required could only be obtained by polishing. With regard to electric driving, Mr. Hardman said he had recently visited a mill where, in order to maintain a steady drive, the ordinary fuses had been taken out of the motor and the largest possible fuses substituted. Although the change entailed a certain amount of risk, it was found to work satisfactorily. As a practical man, he was not in favour of a duplex drive, it was never as efficient as the single drive.

Since 1912 the production of the mule had increased about 10 per cent. At that time a speed of 6000 revolutions per minute was considered very high, but now the average speed was from 8500 to 10,000 revolutions per minute, so that it was impossible to say whether the mule had reached its maximum efficiency. The life of a mule frame was frequently twenty-five years, and with minor repairs it was possible to run frames for forty years. When that figure was compared with the life of a motor car, which was probably not more than five years, the author thought it was a great tribute to the skill and accuracy of textile engineers.

The Creosote Treatment of Sleepers.

By W. KYNOCH, B.Sc.F., F.E., and J. A. CODERRE, B.A., F.E., Forest Products Laboratories of Canada, Montreal.

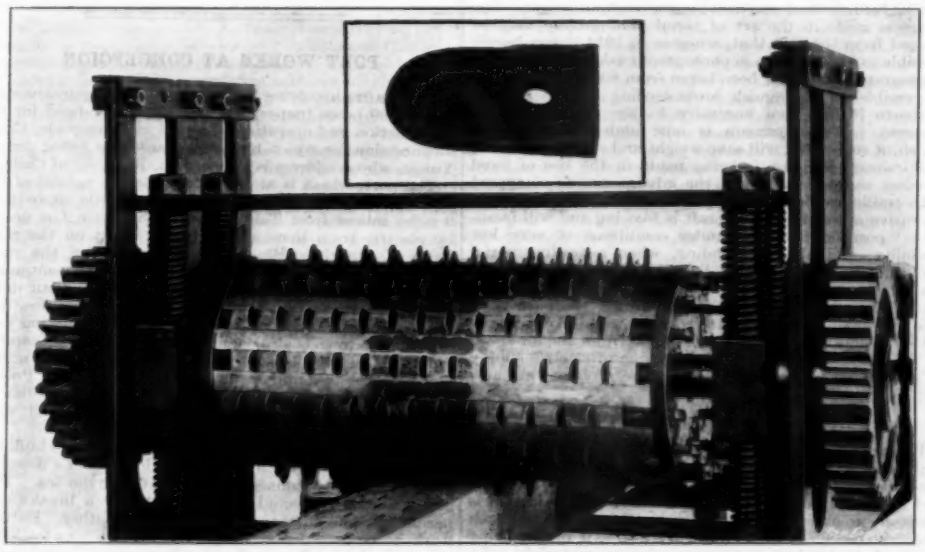
EXTENSIVE research and investigative work in connection with the preservative treatment of railway sleepers has been conducted by the Forest Products Laboratories of Canada—Dominion Forestry Branch—at McGill University, Montreal, during the past seven years. It became apparent, early in this work, that the ordinary commercial creosoting specifications, which require the injection of a certain quantity of preservative per cubic foot of wood, are very unsatisfactory, as even the most rigid adherence to them does not give any certainty that the sleepers are properly protected. The objective in treatment is to obtain, in every sleeper, a uniform penetration of preservative of sufficient depth to provide adequate protection against decay. In actual commercial practice, however, the penetration, even in well seasoned material, is frequently very erratic, especially in the heartwood. The depth of penetration is usually practically an unknown quantity. All that is definitely known is that the charge of timber in the treating cylinder, as a whole, has absorbed a certain quantity of preservative which amounts to the desired number of pounds per cubic foot and thus complies with the specification. In different sleepers in the same cylinder charge and in different parts of the

same sleeper the penetration may range from almost nothing to saturation. If, however, an easy means of controlling the depth of penetration in each sleeper be provided, this unsatisfactory state of affairs is done away with, and a much more efficient treatment is ensured.

A very simple and effective means of obtaining the desired result was worked out at the laboratories several years ago. Prior to creosoting, incisions of a special character were made in the surface of the sleepers lengthways with the grain of the wood. The number, depth and arrangement of these incisions are varied according to the kind of wood to be treated. The sleepers are then creosoted in the ordinary way.

Distribution of the preservative, both lengthwise with and across the grain, proceeds from each incision. The rate of distribution varies with the species of wood, moisture content, character of creosote oil and details of treatment. The number and arrangement of incisions used for any given kind of wood should be such that the penetration from each incision meets that from the adjoining ones in a reasonable time, thus forming a continuous treated zone of uniform thickness completely enclosing and protecting the inner and untreated portion of the wood. The thickness or depth of the treated zone is controlled by the depth of the incisions. The length of time of pressure necessary to secure a given depth of penetration in incised timber is much less than that required to obtain the same depth in the same timber not incised. This becomes evident when it is considered that incising provides in the outer layers of the wood a number of centres from each of which the preservative is simultaneously distributed during treatment. Carefully conducted tests on several kinds of wood have shown that the above is exactly what occurs in incised timber when treated.

Sleepers are incised by passing them through a machine provided with steel rollers—as shown in the accompanying illustration—equipped with removable incising cutters or members. The particular type of incising member finally adopted is shown in an inset in the illustration. These cutters do not crush or break the fibres of the wood, as some other forms tend to do, but merely press them



RAILWAY SLEEPER INCISING MACHINE—INSET, A CUTTER

apart slightly. This is so much the case that after treatment the incisions, narrow to begin with, close up and are hardly noticeable. Tests made at the laboratories indicate that the reduction in strength due to incising is so small as to be quite negligible for practical purposes.

As an illustration of the advantages of incising for both refractory and easily penetrable coniferous timbers, reference may be made to results obtained with two well-known Canadian sleeper woods, namely, eastern hemlock and jack pine, creosoted with and without incisions. The former wood, as is well known, is an extremely refractory one. An extensive experimental investigation at the laboratories failed to develop a satisfactory creosote treatment for this timber by ordinary commercial processes. Jack pine, on the other hand, was found relatively easy to treat. When the timber was incised it was found possible to treat hemlock satisfactorily without any particular difficulty, while an excellent treatment was secured in jack pine in less than half the time necessary to reach a similar result without incisions. Further, the penetration in the incised timber was in all cases much more uniform than in the unincised, and was obtained with less oil per cubic foot.

Incising presents the following advantages :—

(1) In the case of easily penetrable woods a very much better treatment than is usual without incisions, using less creosote oil per cubic foot than is ordinarily specified.

(2) The successful creosote treatment of certain refractory woods.

(3) A shortening of the customary pressure period by at least one half in the case of easily penetrable woods, and therefore—

(4) A considerably increased plant capacity with given equipment.

(5) Satisfactory penetration in every sleeper in a cylinder charge.

A brief account of the development of the incising process and of the results obtained in creosoting incised material was given by the writers some years ago in Bulletin 67 of the Canadian Forestry Branch, entitled "Creosote Treatment of Jack Pine and Eastern Hemlock for Cross-ties." Since this publication appeared, in 1919, a large number of additional tests have been made, the results of which are confirmatory of the conclusions then stated. The investigation has been extended to other woods, and the process has been adopted by the Canadian Pacific Railway Company for the treatment of sleepers.

Progress of Aeronautical Research and Experiment.*

By Air Vice-Marshal Sir W. G. H. SALMOND.

GENERAL CONSIDERATIONS.

RESEARCH is progressing slowly but surely, and in this paper I give some account of the work which has been carried out during the past twelve months.

Work of great value has been carried out in regard to wing sections, with the object particularly of diminishing the length of the run before the aeroplane leaves the ground, and at the same time of reducing landing speeds. The rate of "getting off" is an all-important matter. At the present time the majority of machines have to carry an engine which must be run at maximum power for this purpose. Once the aircraft is in the air the economic and customary flying speeds are obtainable at three-quarters throttle or even less. A certain amount of success has, I am glad to say, been met with in producing aeroplanes which are very much more efficient in "getting off" than their predecessors. If and when we have entirely achieved our object in this particular, the aeroplane would be able to leave the ground with the engine at three-quarters throttle, so that, if desired, a smaller engine could be put in to run at the same power both for "getting off" and for flying.

The problems of aeroplane design which we are particularly considering may be divided roughly into three categories. First, the single-seater fighter, in which the essential quality is high performance at altitude—say, 20,000ft. The next category, again a Service one, embraces a very large number of requirements, such, for example, as the amphibian, the boat machine, the reconnaissance machine, &c. The third category is the civil aeroplane, with which can be coupled the night bomber, troop carrier and ambulance machine. With a single-seater fighter it is necessary to run the engine all out in order to get the requisite performance, and it must therefore be fitted with some means of maintaining power at altitude. This difficult problem is much in our minds.

As regards factors of safety or load factors, research has led us to adopt a factor of safety of 4 for civil machines where straight flying only is required; but for Service machines a figure of 7 is necessary. The nature of the load distribution is of vital importance. It is perhaps a rather difficult matter with regard to civil machines, since you may, for example, have a carrying capacity of ten passengers and only take up three or four. It was at first thought that it might be necessary to weigh each machine before starting so as to get the right load distribution, but this is impracticable and unnecessary. An interesting suggestion has been put forward by Wing-Commander Cave-Browne-Cave to employ a small steelyard weighted to represent the weight of the empty machine. The weight of the baggage and passengers, i.e., variable weight, would be represented by hanging small weights on the yard, and so the centre of gravity of the machine as loaded would be ascertained.

These quite general considerations of the strength of the aeroplane lead to the investigation of fundamentals, of which that on materials comes first; but research by itself on materials must be useless unless ease of production and the possibility of bulk production is ultimately ensured. Materials with ostensibly miraculous properties are frequently submitted for consideration and sometimes they do possess some, at least, of the physical attributes claimed for them; but when regarding them from the production point of view they may be, and all too often are, prohibitive on account of cost, and more often than not are impossible on the bulk production basis. When considering bulk production there is one particular element which must not be lost sight of, namely, the time taken to produce.

As regards fuel, very valuable research has been carried out, and decided advances have been made during the year. Once it is realised that of the total running cost of a machine at least one half is due to fuel, it is evident that research in this direction should be accelerated. For example, the present price of petrol is about £35 per ton, whereas crude oil can be obtained for about £4 per ton, and the same weight of either of these fuels will give approximately the same horse-power. It is of great importance to civil aviation, and to the Royal Air Force, that encouragement should be given to schemes for the direct injection of fuel, both for economy and for doing away with both carburetter and magneto.

* Abstract of paper read at the Air Conference, February 6th.

AERO-ENGINES.

Experiments are being made with an inverted form of the Napier "Lion" engine. If an inverted engine can be made to work successfully it will be possible to improve the pilot's forward view and also lead away the exhaust more satisfactorily than can be done in the ordinary upright engine.

One of the most promising events of the past year has been the development and use at the R.A.E. of a single cylinder of aero-engine type to run on a "Diesel cycle." It is found that with a special shape of nozzle and "solid injection" of shale oil fuel a brake mean effective pressure of as much as 112 lb. per square inch is obtainable, and that with an engine speed of 1000 revolutions per minute. The fuel consumption under these conditions was 0.415 lb. per brake horse-power hour. Work on direct fuel injection is being undertaken also by Messrs. Beardmore. They are making initial tests on a single cylinder with a view to the ultimate adoption of the system in a six-cylinder vertical engine. The method of injection is different from that employed at Farnborough, inasmuch as in the latter oil at from 3000 lb. to 4000 lb. per square inch is admitted through a timed valve, whereas in the Beardmore system the oil is injected by a jerk pump.

A step forward in full-scale experimental research has been made by the perfection of an instrument by means of which an aero-engine can be tested in flight with an accuracy equal to that of the laboratory. This consists of the Callendar electric air flowmeter, which, when attached to the air intake of any multi-cylinder engine, measures the weight of air used independently of a knowledge of the pressure and temperature.

Efforts are being made towards the improvement of the magneto. As a result of investigations carried out at Farnborough, in association with magneto manufacturers, it is hoped to arrive at a design for a universal magneto equally suitable for all aircraft engines and all conditions of normal air operation. It seems likely that the introduction of cobalt steel magnets will greatly affect design. A point that particularly needs looking into to meet the temperature conditions of the Middle East is the mechanical, physical and electrical properties of moulded hard rubbers; this work is in hand. The characteristics of safety gaps at reduced pressures are under investigation with a view to the design particularly of a suitable safety gap for use with super-charged engines.

AEROPLANES.

One of the most difficult problems in the design of aeroplanes is the association of a low landing speed with a high maximum. Both in civil aviation and in service flying it is very desirable that a landing speed of not more than 40 miles per hour should be achieved. In the study of aerodynamics attention has been focussed upon improvement in control at low speeds; stalling is at present accompanied by such deterioration of control that straight flight can only be maintained by rather abnormal skill, and involuntary spins often result. We hope to find means of providing complete control of the orientation of the aeroplane in the stalled state, so that aeroplanes may be flown with confidence at their lowest speeds and the full-speed range utilised. This will greatly increase the chances of effecting forced landings without accident. Various systems of lateral control have been and are being tried, but the greatest improvement has been obtained by the use of a very large rudder. An aeroplane has glided steadily under good control at an angle of incidence of 40 deg. A system of carrying aileron gearing due to Mr. Hagg and the De Havilland Aeroplane Company shows promise of improving the lateral control.

The proposal to use air screws in close tandem form—advanced by Captain G. T. R. Hill at the last Air Conference—is being investigated by running two air screws in this manner on the ground. So far no vibration troubles have occurred. Experiments which have been carried out indicate that a serious loss of efficiency is to be expected if air screws be run at higher tip speeds than the highest now in use, 850 f.p.s.

General Bagnall-Wild, in his paper last year, referred briefly to the position of the helicopter type of machine. There is little to add, except that a certain amount of work has been done, and that it is hoped that the time and effort expended will shortly be repaid.

Metal Propellers.—During the past year very considerable progress has been made in the development of the metal propeller. It may almost be said now that it has proved itself to be satisfactory for replacing the wood propeller hitherto in general use. The main difficulty in producing such an article is not so much a question of actual design as a question of finding out how to make it. This difficulty has now been overcome, and it can be safely said that a satisfactory metal propeller can be made for any type of aircraft, with an efficiency at least as high as that of the wooden one. Still further research is necessary with the aim of investigating various aerofoil shapes in order to determine the most efficient, and one, moreover, which is capable of convenient and rapid manufacture.

The advent of high-powered engines has made the use of the metal propeller almost imperative for both service and commercial use. The propeller required for engines of 600 to 1000 horse-power is so large that its transportation is a very serious problem, and there is little doubt that such propellers must have detachable blades in order to simplify this problem. The design of a propeller with wooden detachable blades is a matter of very great difficulty, whereas the metal propeller is normally so made. The variable pitch propeller follows as a natural sequence the development of the metal propeller. In all variable pitch propellers hitherto made the principal difficulty has been to secure adequate attachment for a wood blade

to a metal centre. With the advent of the metal propeller this difficulty has been removed, and it is thought that a satisfactory variable pitch propeller can now be designed to give the same degree of reliability as existing fixed pitch propellers.

Undercarriages.—The difficulties experienced in the use of aircraft in tropical climates have shown the weakness of rubber as an aircraft material, and steps have been taken to find a substitute, or alternatively to re-design the parts, eliminating rubber as far as practicable. During the year a large amount of research has been carried out on oleo undercarriages. The oleo undercarriage was first developed with a dashpot and rubber tension shock absorber, using rubber in tension as in an ordinary aeroplane undercarriage. These undercarriages have proved a marked advance on the ordinary type hitherto used, but the use of rubber in tension in exposed parts of the aeroplane is undesirable. Efforts have therefore been made to overcome this difficulty. Four types of undercarriages have been developed :—(1) An oleo dashpot combined with rubber buffers, that is, with rubber in compression ; (2) an oleo dashpot combined with a steel spring in compression ; (3) an oleo dashpot combined with compressed air ; (4) a steel spring undercarriage with a variable leverage device. So far as experiments have gone, the oleo carriage with compressed rubber has proved entirely satisfactory. The oleo with a steel spring, whilst displaying adequate shock-absorbing capacity, has so far proved to be too heavy for application to aircraft. If it were possible to obtain a spring made of hollow steel tube, it would be possible to reduce the weight of the spring sufficiently to enable this type of undercarriage to become a practical device for ordinary aeroplanes. Experience of the oleo undercarriage with compressed air is limited, and tests and experiments are still in hand to develop this.

A new form of tail skid is urgently required. Failures of this item are very frequent, and the life is very short indeed. Some forms of oleo tail skids and steel spring tail skids have been devised, and the question generally is receiving attention.

Metal Wheels.—This subject is being investigated with the object of eliminating rubber tires and taking all shocks on the oleo shock-absorbing mechanism.

Variable Camber Gears.—Continued efforts are being made to increase the useful weight carried by aeroplanes. In pursuance of this, research is being carried out with a number of variable camber devices which have been submitted for consideration. These divide themselves into :—(1) The ordinary aerofoil fitted with an adjustable flap at the trailing edge ; (2) the ordinary aerofoil fitted with an adjustable trailing and leading edge ; (3) true variable camber gears which vary the actual camber of the aerofoil ; (4) devices such as the Handley Page slot which fundamentally affect the air flow over the planes ; (5) combinations of the Handley Page slot with the trailing edge flap. A large programme of work on this is in hand, and some measure of success has been achieved.

Metal Construction.—Progress in the development of metal construction has been maintained and considerable sums have been expended in this direction. There is no doubt that the metal aeroplane is now quite practical. Much work has still to be done, however, from the point of view of cost reduction. Such aeroplanes are expensive to make and take a long time to produce. Experience has shown that not only is the metal aeroplane more durable than the wooden aeroplane, but that moderate-sized aeroplanes can be made lighter in metal than in wood. It is believed that this advantage of light structure can be continued in aeroplanes of larger dimensions and that the problem of producing a large aeroplane will be thereby much simplified.

Navigation and Instruments.

An important item in the year's work has been the development of the new type of magnetic compass. It seems likely that the magnetic compass of the future, having moderately heavy liquid damping, will provide the best all-round compass and that such models will be found to have performance greatly in advance of anything previously known, particularly in reference to steadiness in reading, even on "bumpy" days. An alternative kind of magnetic compass known as the inductor compass has been tried by the United States Government. In this a little generator, the armature of which revolves in the earth's horizontal magnetic field, produces a minute electric current which, by certain ingenious mechanical arrangements, is arranged to indicate to a pilot whether he is flying to port or starboard of a course previously laid down. Since a device of this kind lends itself to "repeater" work, it is being carefully watched. Should the introduction of steel construction into modern aircraft render the ordinary compass impossible, such a device as this might prove useful ; so far as steel construction has yet gone it does not, however, appear that this need is likely to arise. The most successful compass for ship use is the gyroscopic compass. The problem of the development of this compass for use in the air is a very difficult one and, although experiments are proceeding, it cannot be said that success is within sight.

An important navigational problem is the provision of means whereby the pilot of a single-seater machine can obtain whilst in flight a sufficiently accurate knowledge of the velocity and direction of the wind to enable him to lay his course correctly. A method which is under consideration is one whereby the pilot flies on any course and when over a conspicuous ground mark starts a stop watch. The course is held for a short time and the machine then turned rapidly on to the reciprocal course and so held for an equal interval of time. At the termination of the second interval the machine can be headed for the original ground mark and will then be flying up wind. The course steered gives the direction from which the wind is blowing and the time taken on this third course divided by the total time of observation gives the ratio of wind velocity to air speed. It is obvious, however, that in any machine having means at will for emitting a smoke puff this operation could be considerably shortened. There is at the same time under trial a method by which pilots can measure the apparent drift of the ground by means of a scale of angles marked on one or other of the lower wings. As is well known, if the drift angle is read on two known courses it is possible to deduce at once the speed and direction of the wind.

With the ever-increasing radius of action of civilian aircraft comes the question of the accuracy with which these distances can be navigated. Either directional wireless or astronomical observations can be used. The latter necessitates accurate observation and facile reduction ; the main problem is to determine, by day or night, the altitude above the horizon of some heavenly body. A sextant which experience has shown to be capable of being employed under air conditions is the R.A.E. bubble sextant. This instrument refers the altitude of a heavenly body to a gravity controlled bubble. The only error of importance to which the instrument is subject is due to horizontal accelerations, resulting in a movement of the "apparent vertical." The latter results in a series of irregular oscillations of the bubble and an observation of a heavenly body should continue sufficiently long to allow a mean to be estimated.

Fog Landing.—The problem of landing in a fog is one of the most troublesome which we have to face. The situation at present is that an aircraft can be led to within approximately two miles of an aerodrome by directional wireless. When the aircraft is within this radius further position finding becomes difficult owing to the time required to take the bearings and to transmit the information back to the aircraft. A scheme is being tried at Croydon whereby the position is rapidly taken by acoustic methods and the information transmitted to the aeroplane by wireless. This method relieves the pilot of the necessity for asking for his position by wireless at a time when he is much occupied with flying the machine. By these and other means a pilot can locate the aerodrome, but the problem of actually landing through the fog remains. We are now investigating the possibility of laying a cable round the aerodrome, in the general shape of a race track, that is to say, with two long straight sides, the ends being curved to an arc convenient for an aeroplane in flight to follow. The cable will carry electrical current and the aeroplane will carry apparatus capable of detecting it and of measuring the energy received. The amount of such energy gives an inverse measure of the height. By this means it is hoped to enable the pilot to locate the actual confines of the landing ground and finally to glide down, even in conditions of very low visibility, with an accurate knowledge of his height at any given moment.

Aerial Survey.—The value of aerial survey is largely dependent upon the accuracy with which the camera can be held vertical and at a known constant height. The progress made in the art of aerial photography may be gauged from the fact that, whereas in 1914 it was barely possible to identify men in photographs taken from 3000ft., photographs have now been taken from 8000ft. in which it is possible to distinguish birds feeding on the ground. Hitherto it has been necessary to use plates in aerial cameras. A film camera is now under development, which, if successful, will save weight and space.

Wireless.—Progress is being made in the use of fixed wireless aerials in aircraft, the advantages as compared with trailing aerials being considerable. Such aerials are operative even when an aircraft is taxi-ing and will facilitate "position finding" under conditions of very low visibility, and also fog landing, when a trailing aerial could not be used. The abolition of accumulators in aircraft on account of their weight is a difficult problem which has received much thought during the past year. The two main difficulties are to drive wind-driven generators at constant revolutions irrespective of the air speed of the aircraft and to provide a source of electric supply to aircraft when stranded. Both these problems are now well on the way to solution.

Materials.

Research work on the fatigue problem is in hand at the Universities of Oxford, Birmingham, Edinburgh, Liverpool, at the Greenwich Naval College and at the N.P.L. and R.A.E. In order to co-ordinate work of the kind it is necessary to ascertain whether the methods of test at each research centre are such as to ensure similar results being obtained from similar tests on similar materials. To investigate this matter one half of one set of samples was sent to Dr. Hatfield and the remaining halves to the N.P.L. The tests, when subsequently compared, showed closely similar results and gave increased confidence in the methods. An important detail, the failure of which is all too common, is the engine valve spring. A research is accordingly in hand to ascertain the nature of the right limits of stress for such parts.

Research work in fatigue has been mainly carried out on steel samples, but as a control experiment tests have been made on the simpler material, nickel ; these have most remarkable results. During fatigue tests on a rotating specimen of nickel, definite "heat bursts" occurred at definite loadings, but did not recur when the test was repeated on the same sample. Professor Jenkin, of Oxford, has made a careful study of the bearings of this and of other similar phenomena ; as a consequence he has been led to a definite theory of the nature of the stress effects on a mass of crystals. A large-scale model illustrative of this theory has been constructed and put under test. The model is surprisingly simple, consisting only of a few rods, springs and blocks of wood ; with it, nevertheless, almost all known phenomena in the fatigue of metals can be reproduced and the curves so found show a remarkable similarity to those obtained from actual metals under fatigue stress. The work is in some ways analogous to that leading to Ewing's famous magnetic models and promises to be equally important as an advance in scientific knowledge.

At the last Air Conference reference was made to the favourable experimental results obtained by the use of petroflex in place of "petrol-resisting" rubber tubing for conveying fuel from tanks to carburetters. Development work during the year has, on the whole, tended in the direction of using metal tubing and metal connections in preference to either alternative, but no final decision is yet possible.

PERUVIAN ENGINEERING NOTES.

In pursuance of the Peruvian Government's plan for the development of railways as private ventures, a contract has been entered into with Mr. B. T. Lee to construct a railway from the city of Yurimaguao to the Pacific, *viâ* Moyobamba. The contract has yet to be verified by Congress, but little difficulty is anticipated in this direction. It is proposed to select on the Pacific some point between Paita and Pacasmayo.

It is intended industrially to develop the agriculturally rich Huallaga River district, and for this purpose a concession has been tentatively granted by the Peruvian Government to a group of New York capitalists. The Huallaga is one of three rivers—the Maranôa and Ucayali are the other two—flowing into the Amazon's basin and watering an exceedingly rich area. A further concession has been granted, also to American interests, to construct a railway to connect the Pacific with a navigable point on the Huallaga River.

An extensive contract has been entered into between a group of Italian capitalists and the Empresas Eléctricas Asociadas de Lima (Peru) for the entire reorganisation and partial reconstruction of the electric light and street railway systems belonging to that company. The systems controlled by this organisation comprise (*a*) the Ferrocarril Urbano de Lima (length 33 kiloms.) in the capital, which carries between 17 and 18 million passengers annually ; (*b*) Tranvías Eléctricas de Lima y Chorillos, an electric light railway 33 kiloms. in length, operating in connection with the Lima tramways ; (*c*) Ferrocarril de Lima y Callao, a light electric railway 15 kiloms. in length, carrying between 3,300,000 and 3,500,000 passengers between the Capital and La Punta ; (*d*) the Compañia Nuéva Tranvía Eléctrica (Lima-Chorillos-Herradura), formerly a competitive line but subsequently incorporated into the system of the Empresas Eléctricas Asociados, carrying between 800,000 and 900,000 passengers ; (*e*) the Empresa Eléctrica de Santa Rosa, supplying the necessary current to all of the above undertakings. The additional capital to be found will exceed £P1,000,000 (£P1 = £1 0s. 0d.), the greater part of which will be devoted to railway projects and the balance to the improvement of other Lima properties. While the management of the reorganised company is Italian, and a considerable proportion of the new equipment will be purchased in Italy, foreign contractors are not excluded from bidding ; in view of the popularity of British electrical equipment and supplies, it is thought that tenders of British contractors should meet with consideration. The offices of the Empresas Eléctricas Asociados are at Lima.

PORT WORKS AT CONCEPCION.

Contracts involving the expenditure of approximately 12,000,000 pesos (paper) will shortly be arranged for the construction and operation of a port at Concepción, Chile, a concession for which has been granted to Señor Arturo Yunge, whose address is Concepción, Republic of Chile.

The port, which is at the same time the capital of the province of Concepción, is situated a little more than 9 miles inland from Talcahuano, with which it is united by electric tram lines and railway. Built on the right bank of the river Bio-Bio, it forms one of the most important towns in the republic. The town contains a large number of factories, including tanneries, flour mills, breweries, engineering establishments, ironfoundries, &c., both gas and electricity being used for illuminating purposes. The town is also connected by rail with the capital, Santiago, and the largest port, Valparaiso, to the north, and with the two important ports of Valdivia and Puerto Montt to the south. The major port of Coronel lies 41 miles south of Talcahuano, and it is connected with Concepción by electric traction.

The new construction called for will include the building of a canal, 67 m. wide by 7½ kiloms. long, with a depth of 9 m. at low tide, connecting the port and the sea. This canal will be protected at the mouth by a breakwater, permitting safe entrance to ships in all weather. Further work to be provided at the port include railway facilities, paved roads, loading and unloading cranes, warehouses, grain elevators, coal-loading devices, pipe lines for oil, &c. The contract calls for the doubling of all facilities at present in force, for handling the tonnage passing through the ports of the province. Plans must be submitted within two years ; construction must commence during the year following the approval of the contract, and be completed within five years afterwards.

The concession is not a monopoly, the State reserving the right to grant similar concessions, while tariffs will be fixed and revised periodically by the President, based on a maximum return of 10 per cent. on the capital invested.

TESTS ON VERTICAL DRILLING MACHINE.

In connection with the new design of vertical drilling machine illustrated and described in last week's issue, the makers, William Asquith, Limited, of Halifax, have written to us stating that they have recently carried out some tests on the machine by way of demonstrating its capacity. It is not claimed that the results of these tests could be reproduced every day under strictly commercial conditions, but it is held that they demonstrate the reserve of power and durability possessed by the machine to meet the most strenuous working conditions. If important improvements should be made in the cutting capacity of twist drills, the machine, the makers are satisfied, will not thereby be rendered obsolete. The test results are as follows :—

Drilling Cast Iron.

Drill diameter. in.	Revolutions per minute.	Feed. c.p.i.	Penetration in inches per min.
3	104	23	4½
2½	164	23	7
2¼	180	23	8
2	180	23	8
1½	240	23	10½
1	405	23	17½

Drilling High-carbon Steel, 40/50 Tons Tensile.

3	104	23	4½
3	104	36	3
2½	142	23	6
2	180	23	8
1½	180	23	8
1½	240	23	10½

Railway Matters.

ON the retirement of Sir William Marwood, K.C.B., which took effect as from January 31st, 1923, Mr. J. R. Brooke, C.B., has been promoted to be secretary to the Ministry of Transport.

OF every pound received by the Great Western Railway Company during the year 1921 10s. 7d. went to the staff in the form of salaries and wages, and 2s. 9d. to the shareholders for dividends.

THE Festiniog Railway Company has been authorised under a Light Railway Order, to make a junction at Portmadoc with the Welsh Highland Light Railway, and to construct a new station at that place.

AT a meeting of the Railway Amalgamation Tribunal on the 31st ult., the scheme submitted by the Railway Companies' Association for the distribution of the £25,000,000 of the second £30,000,000 payable under the Railways Act, 1921, was agreed to.

A PRELIMINARY meeting of representatives of the Railway Companies, Chambers of Commerce, and of the Federation of British Industries, was held on the 29th ult. at the offices of the Association of British Chambers of Commerce to discuss the formation of local joint committees.

WE have recently seen it stated that the extension of the electrification of the London and South-Western section of the Southern Railway from Effingham and Claygate respectively to Guildford will be begun immediately. We have reason to believe that this announcement is premature, and that there has been no change as yet in the intentions as to proceeding with this work.

So far the Central Railway Advisory Councils set up in India, in accordance with a recommendation of the Acworth Committee, have been elected on the State railway systems. The Government has expressed the hope that the company-worked systems will follow suit, and the chairman of the Bengal and North-Western Railway stated on the 30th ult. that his board had no hesitation in agreeing to this proposal.

THE London Underground Railway is now making provision for a record train service to run between Golder's Green and London. An additional track is to be laid down at Golder's Green Station and the number of platforms is to be increased from four to five. The growth in traffic at this station has been remarkable, and last year a record of over 12 million passengers was reached. With the opening of the Hendon and Edgware extensions, the new platform arrangements will permit the running of twenty-eight trains an hour each way instead of eighteen per hour. Golder's Green will thus become one of the best-served centres out of town. At the new Brent Station, four tracks are being provided to secure up and down road passing loops so that expresses to and from Edgware can overtake trains stopping at Brent Station.

THE remark we made in a leading article on November 3rd last, as to one of the brightest hopes in the British railway position being the happy relations between the companies and the men, has been much quoted in the American Press. It is gratifying, therefore, to be able to report that the railway labour situation there bids fair to be brighter than it was. The New York correspondent to the *Economist*, writing under date January 12th, says that the companies' attitude "seems to promise an era of more amicable relations than hitherto between the carriers [railways] and the workers." The companies had filed with the Railroad Labour Board proposals to make drastic changes in service conditions, but about one-half of them have withdrawn the proceedings, and have come, or are coming, to terms with their men as individual companies and not by common agreements.

ON page 707 of our issue of June 30th last we mentioned that the Government proposed to continue the temporary increases allowed to docks and harbours until the question could be looked into, and the Harbours, Docks and Piers (Temporary Increase of Charges) Act, 1922, was the result. The Railway Companies' Association has now announced that a general agreement has been reached (except as regards certain ports on the Firth of Forth) whereby the railway companies have undertaken to modify their applications to the Ministry of Transport made in pursuance of the Harbours, Docks, and Piers (Temporary Increase of Charges) Act, 1922, and the traders have agreed to withdraw the objections lodged by them to these applications. The settlement, it is claimed, illustrates the value of mutual negotiation, and is another instance where friendly discussions have saved both the railway companies and the traders the trouble and expense of arguing their case before an independent tribunal.

THE railway dividends for 1922 are now being announced. The greatest surprise as yet comes from that distressful country, Ireland. In 1913 the Midland Great Western Company paid 3 per cent. for the year, and from 1914 to 1920 inclusive it paid 2 per cent. In 1921 it paid 4 per cent. in the second half, which made 3 per cent. for the year. Now, despite all the adversity it has gone through, it has declared a dividend of 6 per cent. for the second half, making 4 per cent. for the year. The surprise in the English railways is the 7 per cent., as against 2½ per cent. a year ago, for the Great Northern Railway. This increased dividend will absorb about £400,000, and as a sum of £207,000 was taken from reserve a year ago and £60,000 are being placed to reserve now, this means a distribution of about £700,000 extra. The City editor of *The Times*, in commenting on the dividend announcement, said that it was understood that the increased distribution had not been declared out of the compensation money, i.e., that payable at the end of 1922 in accordance with the Railways Act. The financial editor of the *Manchester Guardian* said, however, that "one can only assume that a large draft upon the compensation money has, in fact, been made." Our own opinion is that the money has come from increased earnings, and primarily we base this opinion on the Great Northern chairman's statement on February 10th last that the net receipts for the four and a-half months of de-control in 1921 reached £559,009. That this opinion was correct has since been shown by the report issued on the 1st inst.

Notes and Memoranda.

WITH the object of encouraging the study of short wave lengths by amateurs, French manufacturers are offering several important prizes to those obtaining the best results in receiving or transmission in the Transatlantic trials.

IN an address at the third annual meeting of the American Petroleum Institute, Dr. G. E. Lucke said that the German submarine engine weighs under 50 lb. per horsepower, or less than a tenth of what was regarded previously as a weight limitation.

NOTICE is given by the Iron and Steel Institute that the Council of the Institute is prepared to consider in March applications for grants from the Carnegie Fund, in aid of research work on some subject of practical importance relating to the metallurgy of iron and steel, or allied subjects, and that special application forms may be obtained from the Secretary of the Institute. The results of research work must be communicated in the form of a report.

SOME experiments carried out with different types of miners' electric lamps, described by Messrs. E. Farmer, S. Adams, and A. Stephenson in the *Journal* of the National Institute of Industrial Psychology, show that men using lamps giving six times the usual illumination, although they weighed five times as much as the ordinary lamp, greatly increased the workers' output. The quantity of coal won was increased by over 14 per cent., while the deduction for dirt was reduced by some 21 per cent.

IN an article published in *Science* of January 12th, by Drs. Irving Langmuir and K. H. Kingdon, of the Research Laboratory of the American General Electric Company, particulars are given regarding the thermionic effects caused by alkali vapours in vacuum tubes. The article relates mainly to the effects of the vapour of metallic cæsium, which, like thorium, forms a film on a tungsten filament consisting of a single layer of atoms, and enables a very high electron emission to take place. Similar effects have been observed with the vapours of other alkali metals, notably rubidium. The theory of the subject is detailed in the article.

A NOTABLE expansion has occurred in America during the past year in the use of electric heating devices for industrial processes, particularly in heat treating of metals, baking enamels and foundry cores. Small and medium-size ovens, with 275 to 1000 cubic feet capacity for operation at 100 deg. Fah., have been developed, and furnaces have been built for baking vitreous enamel on bath-tubs with absolute temperature control and freedom from gases and fumes. Electric ovens and low-temperature electric furnaces have also been extensively applied during the past year for melting non-ferrous metals, as well as for heat-treating ferrous metals.

THE fact that the composition of the filling material has much to do with the success of oxy-acetylene welding, states the *Acetylene and Welding Journal*, is demonstrated daily. In a recent case a valve manufacturer who was successfully employing oxy-acetylene welding to reclaim iron castings in which defects showed up during machining was not achieving equal success in attempting to reclaim defective cast steel valve bodies. After making many attempts to overcome the difficulties, the problem was referred to an oxy-acetylene engineer. It was found after a series of tests that a particular welding rod produced satisfactory welds, and the discovery has resulted in the reclamation of quantities of defective cast steel bodies and in the saving of considerable time.

MANY references in text-books and in reference books to the heat value of moist and fibrous fuels are, according to the United States Bureau of Mines, entirely misleading, if not useless. In the first place, heat values may be reported in a variety of ways, and the absence in such references of definite specifications as to which of four different methods is used render them useless. Further—and equally serious—error may arise from dependence for calorific powers on formulas like Dulong's, which assume that all of the oxygen in a fuel is combined before combustion with the hydrogen in that fuel. The error may be slight in fuels containing but little oxygen, but it becomes serious in woody and many other waste fuels high in oxygen. Calculations containing this common error are unsafe and useless, both for comparison of combustion performances and for predicting results in any problem dealing with these fuels.

IN applying automatic control to sub-stations, states the *Electrical World*, many automatic features which have been made a part of modern manually operated stations have been incorporated, but new devices have had to be developed also. Among them are direct-current and alternating-current re-closing circuit breakers and slip relays of the balanced type. The latter will perform the switching operation when a synchronous motor pulls out of step. The high-reluctance commutating pole 60-cycle converter is an accomplishment of the past year. It incorporates flash barriers and a new design of brush holder, which covers only a small portion of the commutator periphery, reduces flashing and makes the brushes readily accessible. The adjustable notching relay which functions after a pre-determined number of operations is another development which has facilitated automatic control.

THE burning of sawdust for boiler purposes is best accomplished by means of a simply constructed "Dutch-oven" furnace, according to the United States Bureau of Mines. As a rule only one feed hole in the roof of the furnace is used, for sawdust is such an excellent fuel that it will produce a hot fire even when handled roughly and carelessly. With a single feeding hole in the top of the Dutch oven, the sawdust forms a cone on the grate surface. A cone is about the least effective form in which any fuel may be arranged on a grate for burning. The draught penetrates the bed of fuel at the points of least resistance, that is, at the shallowest parts; hence the air enters at an excessive rate around the edges of the cone while the largest part of the charge is air-tight and consequently "dead." This difficulty can be reduced or eliminated by different methods, which are described in Technical Paper 279, just issued by the Bureau.

Miscellanea.

IT is announced that the Broken Hill Company's steel works at Newcastle, N.S.W., will resume operations shortly.

THE overhauling of the Leviathan, which is being carried out at Newport Mews, is progressing so slowly that she will not be ready to sail next month, as was originally expected. It is hoped, however, to get her in the Transatlantic passenger service by the middle of June.

IT is understood in Launceston, Tasmania, that operations which have been carried out in the Mt. Cameron district have proved the existence of an extensive and highly-payable tin-bearing area. The developments are believed to be of considerable importance to the North-East Coast of Tasmania, and should give a new impetus to the tin-mining industry.

IT is officially reported that a record output of 11,000 tons of iron ore was obtained in October from the iron mines on the West Coast of Johore, one of the Malay States. In November the output was over 10,000 tons. Applications have been received for the right of mining kaolin, deposits of which are known to extend over a considerable area in Johore.

ACCORDING to investigations carried out by the Japanese Department of Communications, the number of electric power supply concerns in the country at the end of October last was 839, with a total capitalisation of over 2,316,000,000 yen, and when the work of construction now in progress is completed they will be able to supply a total motive power of 1,981,822 kilowatts, of which 1,630,648 will be generated by water power and 351,174 by fuel.

THE permission granted by the Siamese Government to vessels equipped with wireless telegraphy to communicate temporarily with the wireless station in Bangkok from Koh-Si-Chang on account of the submarine cable being out of order, has been withdrawn. The vessel supplied by the Siamese naval authorities, which has for some time past been anchored at Koh-Si-Chang for this purpose, is regarded by the authorities as providing a satisfactory wireless service.

THE French Parliamentary Committee of Commerce is engaged on the consideration of the problem of the general electrification of France. At a meeting of the Committee held recently emphasis was laid upon the national character of the question and the necessity of making an appeal for its solution to a close co-operation of the electricity and railway companies with the members of Parliament. A sub-committee composed of members of the Chamber and manufacturers and technical men is to be appointed to promote this object.

THE Motor Ship Service Corporation, which was incorporated at Sacramento, Cal., on December 12th, 1922, with a capital of 10,000,000 dollars, contemplates an initial equipment of twelve Diesel-driven steamers of 14 knots speed, which will be equipped with the most modern machinery for refrigeration and also for sterilisation and the control of humidity. The vessels will operate between Pacific and Atlantic ports, taking shipments of citrus and deciduous fruits, grapes, vegetables and other suitable cargo. There will be sufficient West-bound freight, it is believed, to make balanced voyages.

THE conference between representatives of the Amalgamated Engineering Union and the Engineering Employers' Federation regarding the wages to be paid to workmen who may be sent abroad to fix up textile machinery has resulted in an agreement being arrived at. Both sides recommend the following rates:—The greater part of Europe, £6 10s. per week. Russia, Turkey, Egypt, and adjacent countries, £7 5s. per week. North America, £7 10s. per week. South America, Japan, China, India, and Southern United States, £9 10s. per week. Australia, New Zealand, and South Africa, £9 10s. per week. East and West Africa, £10 10s. per week.

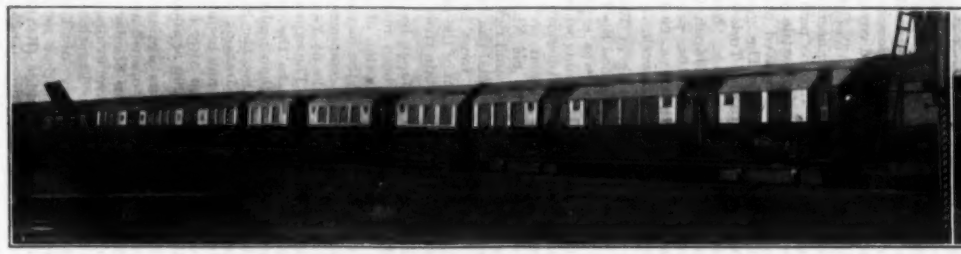
AS a result of a Cabinet meeting at Washington, on February 6th, at which it is understood the Panama Canal receipts were discussed, the hope was expressed at the White House that the time was coming when it would be possible to build another Central American Canal out of the profits accruing from the present one. One of the proposed routes is said to be that *vid* Nicaragua, where the United States already possess canal rights. It is not, however, believed that any new canal can be built in the near future. One obstacle which must be overcome is the claim of Costa Rica to a portion of the proposed route by reason of her ownership of a certain river.

THE demand for silicon iron in Japan has been steadily increasing, but so far none has been manufactured in the country. The present consumption of silicon iron is put at 10,000 tons, and in view of the increasing demand the Government has decided to commence its manufacture at the Imperial Steel Works at Yawata from the beginning of the next fiscal year. The expenditure on the new enterprise will be submitted to the coming session of the Diet, and as it is more than probable that the estimate will be passed by the Diet the Steel Works is already engaged in making preparations for its manufacture. At first the output will not be more than 5000 tons a year, but it is expected that after a few years the production will be increased to 7000 or 8000 tons.

THE great fight of motor users against the present system of motor vehicle taxation opened at Westminster on January 26th, when Sir Arthur Stanley, Chairman of the Royal Automobile Club, gave evidence before the Departmental Committee on the Taxation and Regulation of Road Vehicles (Ministry of Transport). Sir Henry Maybury presided; and other members of the committee are Sir Thomas Berridge (Royal Automobile Club), Major Stenson Cooke (Automobile Association), Mr. Sidney Straker (Society of Motor Manufacturers and Traders), and representatives of local authorities, police, agriculture, Customs and Excise, and commercial motors. A proposed new system of motor taxation by a flat rate duty on motor spirit, has been laid before the Departmental Committee by the principal motor organisations, representing all classes of motor vehicle owners and every branch of the motor industry.

NEW ROLLING STOCK FOR LONDON TUBE RAILWAYS

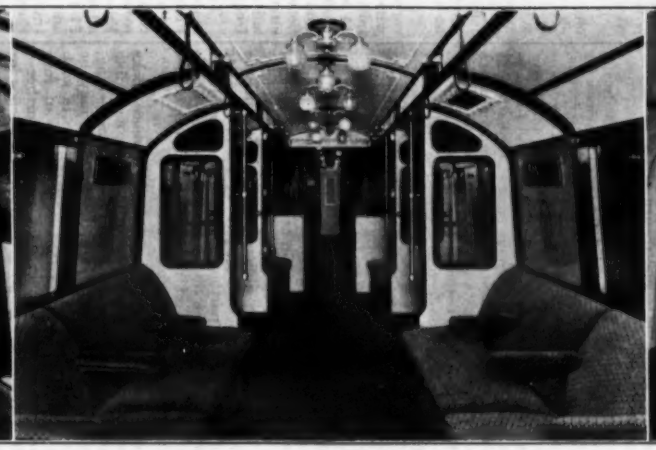
(*For description see page* 144)



TRAIN INCLUDING CARS Nos. 720, 820, AND 821

TRAIN INCLUDING CARS Nos. 822, 823, AND 824

ORDINARY TUBE CAR

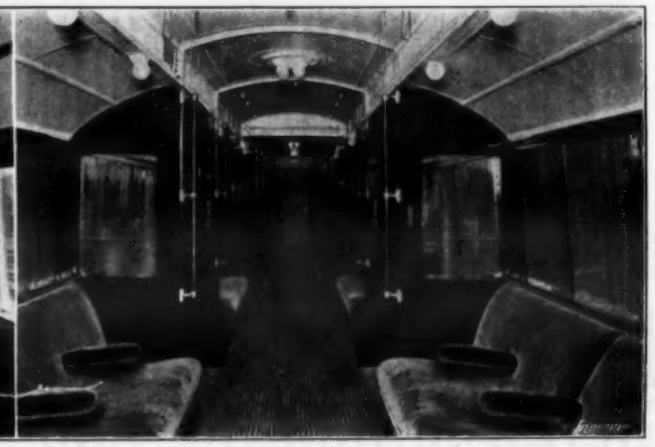


CAR 823 (BIRMINGHAM)

CAR 824 (CAMMELL LAIRD)

CAR 720 (GLOUCESTER)

CAR 821 (LEEDS FORGE)



CAR 822 (METROPOLITAN)

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The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.
CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.
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FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris.
CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
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ITALY.—MAGLIONI AND STRINI, 307, Corso, Rome; FRATELLI TREVES, Corso Umbarto I, 174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan.
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THE ENGINEER.

FEBRUARY 9, 1923.

Super Power Stations.

LIKE many other technical discussions, that on "The Public Supply of Electricity," which took place at the joint meeting of the Institutions of Mechanical, Civil and Electrical Engineers at Birmingham on January 25th, and which was fully reported in our last number, did not, on the whole, bring very much new information to light. Two of the most important points which arose during the evening were that super-power-stations must be given no monopoly of electricity supply, and that, whilst the large power station undoubtedly offers advantages, it is not expedient to scrap all existing stations at one clean sweep. Proposals to abolish existing stations, and especially the best-managed stations, should be considered with extreme care, for it might easily happen that, although in some ways the generation of current in a small number of large stations would be beneficial, there would be no advance in the direction of supplying cheap current to consumers. This, of course, is just as important as the question of saving coal, for unless the long-promised cheap current becomes available the electrical industry as a whole cannot make headway. It must never be forgotten that the cost at the station bus-bars is one thing and the cost at the consumer's machine another. The economy secured in the former may be wholly sacrificed in transmission expenses.

Many seemed to imagine, when the report on electricity supply was issued by the Coal Conservation Sub-Committee in 1917, that as soon as the war was over super-power-houses would be erected forthwith and that the bulk of existing stations would very soon be put out of action; but it has since been found that the reorganisation of electricity supplies in this country is anything but a simple task, and that many things have to be taken into account before it can be accomplished. As far as the erection of super-power stations such as portrayed in the report is concerned, practically nothing has been done. These stations, it will be remembered, were to contain generating sets rated at 25,000 or 50,000 kilowatts, and it was suggested that the plants should be designed so that, as methods were perfected for extracting by-products from the fuel before using it for the production of electric power, by-product plants could be added. Much was also said in the report about the utilisation of waste heat, but here again these suggestions have not as yet been put into practice. In all probability those who were responsible for the report did not fully realise the financial conditions which would prevail in this country at the conclusion of the war. The wholesale scrapping of stations cannot be tolerated in these days when labour and materials are so costly. At present there seems to be no very marked desire on the part of English engineers to use 25,000 or 50,000-kilowatt turbo-generator sets. Continuity of supply is, of course, the most important factor of all, and there are not a few engineers who prefer to split their plant up into medium-sized sections rather than employ machines of abnormally large output. Ten thousand and fifteen thousand-kilowatt units seem to be the most usual sizes now called for, although larger units have, of course, been built by British firms. Before we start on a new policy there is much to be said for the practice of interconnecting the best existing power stations. Apart from increased reliability, the interconnection of stations is undoubtedly advantageous from the point of view of saving coal. It enables them to be worked economically over week-ends and at other times of light loads, for during these periods some of the stations can be shut down altogether; indeed, it gives to a group that high diversity factor which is advanced as one of the prominent arguments for super-power supply. Linking up is not, however, by any means a complete cure for uneconomical working. Everyone admits that many small and inefficient stations must be shut down altogether before the degree of fuel economy which is being aimed at can be secured, but we may fairly look for an improvement of many of the medium-power stations. The tables of consumption issued about a year ago by the Electricity Commissioners have had an excellent effect by stimulating effort and encouraging emulation between stations, and we venture to hope that a marked improvement in the average figures will be shown by the tables for the past year, which are already overdue. One serious objection to concentration of supply in great centres must not be forgotten. In time of war such concentration would be embarrassing, particularly since the improvement of aerial attack, and would make the defence of such stations, whose positions would all be accurately known to the enemy, extremely difficult. Again, it remains to be proved that the suggested super-power stations can supply the railways to the best advantage. It is still far from certain that the current they propose to provide will meet the requirements of all railways in the near future. Irrespective of whether trains are operated with high-tension direct current or alternating current, a periodicity of 25 cycles is undoubtedly better than 50 cycles for traction work. On the other hand, for ordinary industrial purposes the higher periodicity is no doubt advantageous. For rotary converters, however, and especially those built for high pressure, 25-cycle current is unquestionably preferable. Of course, if other converting arrangements are adopted, or if it becomes possible to work single-phase railways with 50-cycle current, as we suggested last week, the objection to this current for railway work will be removed. But in any case it is not easy to see, now that so much 25-cycle plant has been put into operation in this country, how a standard periodicity of 50 cycles per second can be adopted without causing serious disorganisation. In the first annual report of the Electricity Commissioners the difficulties that are met with in connection with the adoption of a standard periodicity are clearly set forth. Unfortunately, periodicity is not an easy thing to change, and the abolition of all frequencies other than 50 cycles per second would involve very great expense and inconvenience.

Altogether the reorganisation of the electricity supplies is a very complicated problem, which must of necessity take a long time to solve. The requirements of the railway companies and the industrial consumer are not, as we have shown, precisely alike, and although the policy of supplying current for all purposes from super-power stations is in many respects a good one, there is not much doubt that in some ways an independent supply for traction purposes is preferable. Whilst the former scheme is pretty generally favoured in this country, in America and elsewhere the Swiss engineers strongly contend that no matter what system of electric traction is adopted, the railway supply and general supply should be kept entirely distinct.

The British Railway Wagon.

OUR four-wheeled railway wagon, with a capacity, generally, of 8 to 12 tons, has often been the subject for humorous reference by Americans, who have contrasted it with their own 60 to 75-ton bogie freight car. In this, as in other directions where the practice of the two nations greatly differs, there is method in our apparent madness. The big wagon is not a practicable proposition in this

country. Our merchandise is usually handled in retail lots which the trader expects to be delivered within two or three days, and he would protest against his consignment being held back until the full load for a big wagon was obtained. Turntables are a necessity in goods warehouses, and usually they are only 13ft. in diameter. Many stations, too, require traversers and hoists which are also of that dimension. The retention of the small wagon for mineral traffic is due to the same and other reasons. Besides turntables, traversers and hoists there are screens at the colliery and tips at the docks, built to suit the usual British truck. The expense of altering this equipment is the main obstacle to the use of a big mineral wagon for the transit of coal for shipment. Its employment in the conveyance of domestic coal is considered impracticable because the merchant, who has to deal in various classes of coal, objects to taking his supplies otherwise than in as small quantities as possible. At the end of last century and at the beginning of this the apostles of the adoption of American methods for the salvation of British railways proclaimed the gospel of the big wagon, and some went as far as to practise what they preached. But it is significant that the Great Northern, Great Western, Lancashire and Yorkshire, North-Eastern, and Caledonian companies were the only railways using bogie wagons at the end of 1921, and of these companies the Great Western had only fifteen vehicles of the kind. The four other companies had, between them, 137 open merchandise, 151 covered merchandise, and 229 mineral bogie wagons. Yet the agitation had a good effect, as it led to a greater carrying capacity being given to the four-wheeled wagon, and whilst to-day the majority of the railway-owned wagons carry 10 to 12 tons, there were, out of 663,926 wagons in Great Britain, at the end of 1921, only 20,357 of less than 8 tons capacity and 30,576 of over 12 tons and less than 20 tons. It is obvious that the reform desired is the retention of the four-wheeled wagon, whilst giving it a greater carrying capacity. The tare load per wagon and the load in relation to the length of the train would then be greater and less shunting mileage to the tonnage carried would be required. Although modern engines could handle longer trains than they do, it is very doubtful that trains could conveniently be of greater length than now. The capacity of refuge sidings, the distance runaway catchpoints are from the home signal, and the amount of brake power available are factors against any addition to the length. When continuous brakes are provided for goods trains the situation will, however, be changed for the better, as the two latter factors and other drawbacks will disappear.

The remedy for the present unsatisfactory position advocated by Mr. H. N. Gresley at the Institute of Transport on Monday evening last was the adoption of the continental four-wheeled wagon for merchandise traffic. We should then have a 22ft. open and a 24ft. covered wagon instead of the present 16ft. and 18ft. wagons respectively, and should increase the carrying capacity of the open wagon from 322 cubic feet to 764 cubic feet and of the covered wagon from 950 cubic feet to 1429 cubic feet. Fewer wagons would, consequently, need renewal and the estimated savings thereby would be equal to 5 per cent. interest on a capital outlay of ten million pounds, which, in Mr. Gresley's opinion, is a sum much greater than would be necessary to alter loading docks, turntables and hoists to provide for the longer, wider and higher wagon. For mineral traffic Mr. Gresley would have nothing less than a 20-ton wagon and would prefer one of 50 tons capacity. He gave some interesting new figures with regard to the latter, as a result of some tests made with dynamometer cars last May. These tests showed that a train carrying 1000 tons in 50-ton wagons, as compared with one carrying the same weight in 20-ton wagons, exhibited a reduction of 32 per cent. in the total resistances, a decrease of 43 per cent. in resistance of total paying load and an increase of 19 per cent. in the paying load. Yet the 20-ton wagon seems to us eminently the more practicable despite the fact that its adoption, as has already been mentioned, would mean alteration to coal-handling plant at the pits and at the docks—much more at the latter than at the former. Whilst the railway company has most to gain by a bigger wagon, the coalowner and the dock authority also benefit because of the fewer wagons to be handled for each thousand tons of coal loaded and shipped. This inducement is not, however, big enough to make the coalowner scrap his 10 or 12-ton wagons, and Mr. Gresley suggests, therefore, that the railway rates should be adjusted so as to encourage the use of the 20-ton. There would then, he observed, be a demand which the dock owners could not resist without jeopardising their income to supply suitable tipping appliances for the larger wagon. It must be remembered, in this connection, that railway companies are the biggest dock owners where shipment of coal is concerned. The question of the privately owned wagon is once more in the foreground because, as Mr. Gresley remarked, now that prices are beginning to come down, orders are being placed much more freely for the construction of new wagons. This fact indicates that, with the present wagon-hire charges, it is more profitable to colliery companies to run their own wagons. The privately owned wagon has been spoken of as a bane to progress and as a curse to British railways. Whilst agreeing that were all wagons railway owned the railways would be masters in their own house, it remains, we submit, the fact that the coal-owners' wagon was in existence before the railways, and that, by the companies refusing to provide wagons for Class A traffic, its presence on the rails has been invited, encouraged and enforced. Contrary, again, to the prevalent opinion, there are, too, fewer accidents with privately owned wagons than with those railway owned. Moreover, were all the trucks to pass into the possession of the companies, those that carry coal—whether for shipment or industrial or domestic purposes—must return empty after unloading and must still be sorted out in the shunting yards for the various distributing areas and be there again marshalled for supplying the different pits. If, however, the companies really desire to abolish the privately owned wagon the remedy is in their own hands. Mr. Gresley states that the principal reason why it remains is that the wagon-hire charges of railway companies are more than the colliery companies have to incur in providing and maintaining wagons of their own. Hence, if wagon-hire could be so adjusted that there was no advantage to a colliery company in owning its wagons, private ownership would largely disappear. Such disappearance, let us add, would remove one of the main obstacles to the provision of continuous brakes to goods trains.

The problem of the railway wagon, like every other problem of progress, in an already highly developed country is made doubly complicated by the fact that it is related to many other things. It is easy for Americans to tell us to increase the size of wagons, but unless they can show us how to increase all related plant at the same time at small cost and convert all traders from methods that have grown up during a hundred years of transport, they have not solved the problem. Admitting that the change is good, we must be content to effect it gradually, and for that reason Mr. Gresley's proposals are particularly worthy of consideration.

Obituary.

MARK HEATON ROBINSON.

THE death of Mr. Mark Robinson, which occurred at Thames Ditton on February 2nd, removes a very familiar figure from engineering circles, for although Mr. Robinson was not an engineer in the strict sense of the word which we employ to-day, he had been for so many years closely associated with engineering firms and was connected with so many engineering institutions that he was regarded by all who knew him as an engineer of the first position. He was born in 1844 and was therefore in his seventy-ninth year, and his death occurred after a prolonged illness which had practically incapacitated him for many months past. His father was Commander Edward Robinson, R.N., and his early education was received in the Royal Naval School at New Cross. From 1861 to 1874 he was employed at the Admiralty. His engineering began by his association with Mr. P. W. Willans, with whom he founded in 1880 the famous firm of Willans and Robinson, which, beginning in a small way at Thames Ditton, ultimately reached such a position of importance that it had to move into larger works at Rugby. Mr. Robinson became chairman of the company after Willans' death, and retained that position until 1909, when his state of health obliged him to relinquish it. From that date onwards he was connected with various other companies, particularly with the Pioneer Company, which was formed to develop Sandwich, and of which he was chairman. The work of development was stopped by the war, and eventually the undertaking was assumed by the Government and became well known under the name of Richborough.

Although, as we have said, Mr. Robinson was not an engineer, he had to his credit two inventions of considerable merit. The first of these was the boat detaching gear, which he designed when still at the Admiralty, and for which he was awarded a premium. The first hooks were made in a small workshop fitted up in the basement of his house in Teddington, with the addition of a blacksmithy about half a mile away. Subsequently, the manufacture of the gear was carried on at a small works at Chiswick managed by a cousin of Mr. Robinson's, the late Commander Harry Robinson, R.N. The gear is still used exclusively in the Navy, and during the war the business so increased that the company was requested by the Government to enlarge its premises to cope with the work. Heavy expenditure of capital was involved, but before any adequate return could be made, the war came to an end, and all further orders were cancelled. The result, as in so many other cases, was disastrous to the company, for the war left the Navy stocked with surplus gear sufficient to last for many years. The other invention with which Mr. Robinson is to be credited is the air buffer, which made it possible for a single-acting engine of the Willans central valve type to compete with other engines in economy of steam consumption and maintenance cost. The Willans engine, as we all know, enjoyed a long period of marked success, and only fell off in popularity when the system of forced lubrication introduced by Belliss and Morcom made the high-speed double-acting engine a complete success.

We have spoken of Mr. Robinson's connection with Richborough, and it may be desirable to say a few more words on that subject. The Sandwich Haven Wharves Syndicate, Limited, was established in 1911, and Mr. Robinson was chairman of it from that date until the time of his death. It was in connection with this syndicate that in the year 1913 he prepared a scheme for the building of a harbour and quays at the mouth of the Stour for the shipment of coal which it was felt sure would be raised by the collieries working a very short distance away. He himself was chairman of the Ebbsfleet Coal Syndicate, Limited. One of the principal points in his scheme was the formation of a new entrance channel seawards by dredging between training walls or piers, and so forming a permanent narrow channel which the scour of the river itself would largely help in clearing of deposit, as he was convinced that in no other way could the channel be prevented from filling up. His opinion on this matter is confirmed by the fact that the channel used by the military authorities in connection with the port of Richborough is kept clear in this manner.

No review, however brief, of the career of Mr. Robinson would be complete without an allusion to the great work he did for the Institution of Mechanical Engineers, of which he was for many years the honoured treasurer. No man ever served an institution more faithfully than Mr. Robinson, and under his control the financial conditions of the Institution of Mechanical Engineers were put on a sound basis. He was a Vice-president of that Institution, and would have occupied the presidential chair in succession to his old associate, Captain Riall Sankey, had not the conditions of his health prevented him from doing so. We believe he had no greater disappointment in life than his failure to secure a position for which he had worked so hard and which he so greatly coveted, and it was to the general regret of the members and of all who knew him intimately in connection with the Institution that he was unable to fill that position.

ALEXANDER ROSS.

OUR readers will have heard with regret of the sudden death, on Saturday last, of Mr. Alexander Ross, who was President of the Institution of Civil Engineers in 1915-16. Mr. Ross was born in April, 1845, and was educated at Aberdeen and Owens College, Manchester, now the Victoria University. He entered the Great North of Scotland Railway Company as a pupil in 1862, and at the end of 1871 was appointed assistant on the civil engineering staff of the Northern Division of the London and North-Western Railway. A few years later he took the position of district engineer to the same company at Liverpool. In 1884 he joined the Lancashire and Yorkshire Railway and remained with that company for seven years as assistant engineer, leaving it in 1890 to take up the post of chief engineer to the Manchester, Sheffield and Lincolnshire Railway, which subsequently became the Great Central. After six years he was offered the position of chief engineer to the Great Northern Railway, which he filled until 1911, when he went into private practice as a consulting engineer in Westminster.

With such a varied and extended experience it is natural that Mr. Ross should have been engaged upon many important works, amongst which may be mentioned the Piccadilly tube, between Finsbury Park and the Strand. The problem of London traffic always interested him, and the scheme for linking up the railways of the northern part of the Metropolis by an outer circle line had his warm support. He also proposed the construction of a passenger subway from the House of Commons to Whitehall Gardens.

During the Great War—in which he lost two sons—he served on the Metropolitan Munitions Committee, and was responsible in large part for the design and construction of the Perivale Filling Factory. He was a member of many important committees, amongst which we may mention that on the Deterioration of Structures Exposed to Sea Action—

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a Committee of the Institution of Civil Engineers appointed a short time ago; the Standing Committee on Engineering of the Scientific and Industrial Research Department; and last, but not least, the British Engineering Standards Association, of which he was appointed in 1912 chairman of the Committee on Railway and Tramway Rails, remaining in that position till 1922, when the work was completed. He took keen interest in the work of the Association to the last, and only a few hours before his death called at its offices in connection with the work of the Committee to Standardise Sand-lime Bricks.

His was a very familiar figure in Westminster and at the Council table of the Institution of Civil Engineers, but few would have guessed the great age he had attained, for to the last he maintained an alertness of mind and body that we associate with younger men. The suddenness of his death caused a great shock to London engineers who saw him almost daily.

Wagon Stock on British Railways.

AT the meeting of the Institute of Transport which was held at the Institution of Electrical Engineers on Monday, the 5th inst., Mr. H. N. Gresley set out to emphasise the economies which would be effected if larger wagons were employed for conveying goods in general and specially in mineral traffic. He advocated an increase in the length of open wagons from 16ft. up to 22ft., and for covered trucks from 18ft. up to 24ft., incidentally remarking that it was cubic capacity, rather than tonnage, that was the important measurement for goods trucks. There are, he said, 480,000 merchandise wagons, excluding coal wagons and those privately owned, in use on British railways, and of these 390,000 are of the open type, while 90,000 are closed. Assuming a life of twenty-five years and a renewal cost of £130 per open and £200 per covered wagon, costs which, he said, would shortly be realised, 15,600 open and 3600 covered wagons would have to be renewed annually at a cost of £2,748,000. A similar cubic capacity could be obtained in twenty-five years by the construction annually of 8000 open and 2400 covered wagons, if built to the suggested dimensions, at an approximate cost of £2,200,000, which would mean an annual saving in renewal expenditure of £548,000. Capitalised at 5 per cent., this represents a sum of over £10,000,000.

Putting the larger wagons into service would naturally entail some alteration in the terminal facilities of the railways; but he thought that an expenditure of much less than £10,000,000 over and above ordinary renewals would be necessary to effect the changes required.

After pointing out the advantages which would accrue to the users and to the railways—specially the latter—through the adoption of the larger 20-ton wagons, Mr. Gresley went on to give an account of some experiments that he had carried out to determine the resistance to traction of the ordinary 10-ton four-wheeled wagon and that of 50-ton bogie wagons. These trials were made on the Great Northern between Peterborough and Boston, over a route which is practically level and straight, and in very favourable weather. In order to ensure that both types of vehicle were tested under conditions as nearly similar as possible, they were both made up into one train and tested simultaneously. The train comprised a powerful locomotive, a dynamometer car, six 50-ton bogie wagons, another dynamometer car, thirty 10-ton wagons, and a brake van. It will be noticed that the carrying capacity of both sets of wagons was the same. The dynamometer cars were lent by the North-Eastern and the Great Western Railways, and were calibrated against one another by being coupled in opposition. The make-up of the train was also reversed occasionally in order to eliminate any error due to differences in the dynamometer cars. The total weight of this train behind the tender was 965 tons. Subsequently the load was increased to forty-five 10-ton trucks and nine 50-ton trucks, when the train weighed 1408 tons 18 cwt., and had a length of 1439ft.

The results of sixteen trial trips, which naturally gave sixteen readings for the resistance of each type of wagon, were plotted as curves, and from these the following table has been compiled, the figures being taken to the nearest quarter-pound.

Speed, m.p.h.	Resistance, lb. per ton. 10-ton wagons.	50-ton wagons.
10	4¼	3¼
20	4¼	3¼
30	5¼	3¼
40	8	4¼
50	12¼	6¼

Applying these figures to two loaded trains, one composed of 10-ton wagons and the other of 50-ton wagons, each of 1000 tons gross load running on straight level track at 30 miles per hour, this being about the speed of unbraked trains on the level, Mr. Gresley arrived at the conclusions which are set out in tabular form at the head of the next column.

From the figures given it is seen that an increase in paying load of 120 tons is obtained on the 50-ton wagon train, with a reduction in the total train resistance of 1750 lb.

	Train composed of 10-ton wagons.	50-ton wagons.
Gross weight, tons	1000	1000
Paying load, tons	625	745
Tractive resistance, lb. per ton	5¼	3¼
Total resistance, lb.	5500	3750
Resistance of paying load, lb. per ton	8.8	5
Decrease in resistance of paying load, per cent.	—	43
Increase in paying load, tons	—	120
Ditto, per cent.	—	19

At the invitation of the President, Sir Sam Fay, Colonel Pringle opened the discussion, and fully endorsed the results of Mr. Gresley's experiments. The figures he had recorded were not, said Colonel Pringle, necessarily lower than what might be expected, and were of much the same order as those determined in 1886 by Wellington, who was considered to be an authority on the subject. He had found that with a normal American freight train the resistance was 4 lb. per ton for speeds up to 25 miles per hour, but that it might be as low as 3 lb. or go up to from 6 lb. to 8 lb. in bad conditions. The average capacity of American wagons in those days ranged between 20 and 30 tons. There was, Colonel Pringle thought, one serious objection to the use of larger wagons on British railways, and that was the consequent reduction in the space between adjacent trains in sidings, which would increase the risk of injury to the shunters. On the other hand, however, the introduction of the big trucks would naturally involve the adoption of continuous brakes, and for that reason alone he thought it would be wise to advocate the change regardless of the direct economies it would effect.

Mr. Ross Johnson discussed the subject from the point of view of the dock owner, and said that his experience at the Bristol docks showed that cubic capacity was more important than the tonnage of trucks. Thus a 10-ton truck would only hold sixty sacks of wheat, and they weighed only 6 tons. It might be argued that that would be sufficient capacity for any one consignment, but he found that more than 25 per cent. of the orders received at the docks were for lots of over sixty sacks, so that larger trucks would obviously be more economical. Dock owners, he said, liked big wagons, although their sheeting equipment was sometimes defective, and occasionally large trucks of awkward dimensions arrived from distant parts and caused obstruction on the sidings. Mr. Johnson asked if it would not be possible for the Railway Clearing House to issue standard dimensions for rolling stock, so that dock engineers might design their fixed structures to clear all types of trucks.

Mr. J. Pike spoke chiefly on the apathy, or even antagonism, of users towards any increase in the capacity of trucks. There were, he said, six tips on the Mersey specially built to accommodate 20-ton coal wagons. When they were completed all the surrounding collieries were canvassed and urged to take advantage of the new facilities, but it was extremely rare for a 20-ton truck to arrive at the tips. The colliery owners said that they did not care for 20-ton trucks, as they wanted their wagons to be interchangeable for the export or domestic business, and there would be far too much delay in unloading the larger trucks at small wayside stations. The tips in question were, in fact, an example of the money which might be wasted in alterations on account of the opposition of truck users.

Sir Sam Fay's remarks were of much the same tone. He had, he said, built some 20-ton hoists and wagons to match them, but when the collieries were approached they said that the trucks would not go under their screens. When it was pointed out that there was clearance enough the pit people said that the larger wagons could only be filled at the spouts if they were moved during the process. Even when the railway company offered a rebate of 3d. per ton on the freight by 20-ton trucks the colliery owners were still against the change. Finally, Sir Sam persuaded a firm of coal exporters to charter a complete train of 20-ton trucks and to keep it as a unit; but although the company was a valuable customer to the pits the scheme was spoiled after two or three months, and ultimately the big trucks had to be used up in the locomotive coal traffic of the railway itself.

Mr. Burt said that the North-Eastern had stopped building 10-ton trucks entirely, and had standardised the 20-ton wagon for mineral traffic, while in Germany the works which were employed in repairing the rolling stock damaged during the war were concentrating their efforts on the larger, or 20-ton, trucks to the exclusion of the smaller wagons.

Mr. Gresley replied briefly to the discussion, and said that the Clearing House had recently issued standard specifications for trucks, which recommended lengths of 17ft. 6in. and 16ft. 6in., although as long ago as fifteen years he had introduced 19ft. trucks on the Great Northern. He was sorry now that when he decided on 19ft. as the limit he had not had the courage to recommend the scrapping of the hoists which set that limit and to go in for even larger wagons. The capital cost of the change would have been recouped over and over again in the interval.

DRAINAGE WORKS IN PERU.

THE forthcoming expenditure by the Peruvian Government of £5,000,000—the proceeds of a loan recently completed—entirely upon drainage works, offers favourable opportunities for British manufacturers of sanitary appliances. The Government's sanitary organisation has now attained a very high standard, the various services having been centralised, while the provision, at length, of ample funds will enable long-existing defects to be remedied, both in the capital and throughout the provinces. With this idea, the Government will establish in each departmental capital a sanitary office, with a medical department and the assistants and inspectors which each service demands. The Ministry of Works is now preparing a Bill before Congress with this object in view.

The principal contracts entered into at present include the installation of a drainage system for the urban district of the Santa Peatriz estate, adjacent to the Avenida Leguia, and a filtration installation at the main reservoir of Atarjea, which is being improved and extended. The Government has also adopted plans for the following enterprises:—(*a*) An adequate water and sewerage system in each town; (*b*) an efficient refuse collection and destruction system; (*c*) street paving, with a properly organised cleansing system, for each town; (*d*) a survey and adjustment of the irrigation system, with the view of avoiding the formation of malaria breeding swamps; and (*e*) the initiation and rigid enforcement of rat-proofing.

The topography of the country lends itself easily to sewerage construction, the ground dipping gently to the south-east. The climate of the country is generally dry, rain occurring only in June and September, when there are light precipitations, while in the capital—Lima—rain never falls. The Lima system at present in force is in bad repair, as a result of too steep gradients, the bottom of the sewers being subject to wear and cracks developing. The main sewers are of brick, ovoid in form, 4ft. 7in. major by 2ft. 7½in. minor axis. Smaller sewers of the same form are 3ft. 3½in. by 1ft. 3½in. All sewers are flushed by the waters from the river that flows through the city.

The city of Lima at present possesses 90 kiloms. (55.92 miles) of sewers, comprising mixed ancient and modern construction. This proving far from satisfactory, the municipality has decided to replace the whole of its network by a new sewer of 120 kiloms. (74.56 miles), and to install a purification plant. Of the 15,000 buildings in Lima, about 20 per cent. are without sewer connection.

BOOKS RECEIVED.

The Internal Combustion Engine. Vol. I.: Slow-speed Engines. By H. R. Ricardo. London: Blackie and Son, Limited. Price 30s. net.

Modern Gasworks Chemistry. By Geoffrey Weyman, D.Sc., F.I.C. London: Benn Brothers, Limited, 8, Bouverie-street, E.C. 4. Price 25s. net.

Shop Arithmetic for the Machinist. By Erik Oberg. London: The Machinery Publishing Company, Limited, 51–52, Chancery-lane, W.C. 2. Price 5s. net.

Information of the Subject of Trade Marks. London: Haseltine, Lake and Co., 28, Southampton-buildings, Chancery-lane, W.C. 2. Complimentary to clients. Price 10s. 6d.

New South Wales Government Railways and Tramways. Report of the Commissioners for the Year ended June 30th, 1922. Sydney, N.S.W.: John Spence, Acting Government Printer. Price 4s. 3d.

Railway Permanent Way: Dimensional Theory and Practice. A manual for engineers, inspectors, foremen, &c. By William Hepworth and J. Thos. Lee. Manchester: Charles Lever, 40, King-street West. Price 12s. 6d. net.

The Blast-furnace and the Manufacture of Pig Iron. Third edition. By Robert Forsythe (deceased). Completely revised by C. A. Meissner and J. A. Mohr. New York: U.P.C. Book Company, Inc., 243, West 39th-street. Price 4 dols.

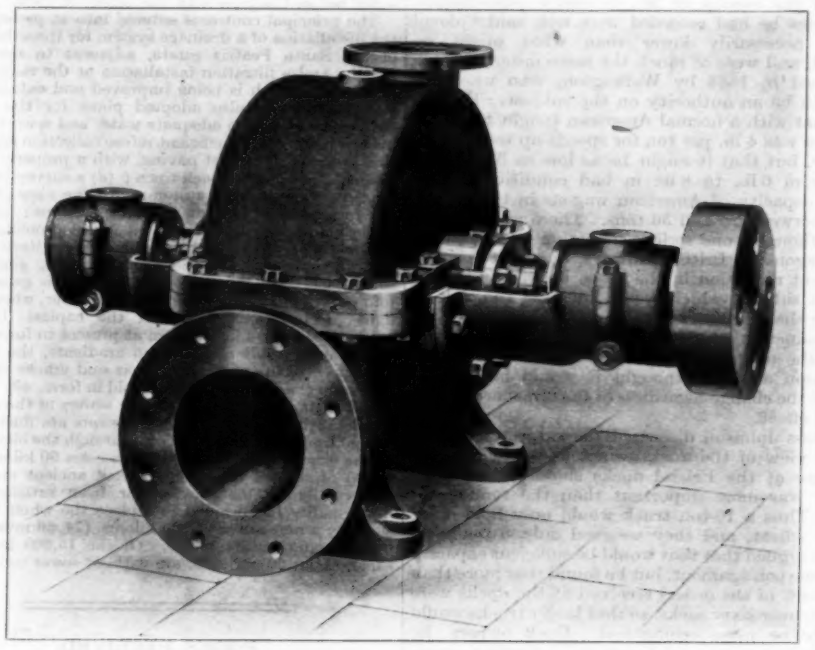
Materials of Construction: Their Manufacture and Properties. By the late Professor Adelbert P. Mills. Second edition, edited by H. W. Hayward. London: Chapman and Hall, Limited, 11, Henrietta-street, Covent Garden, W.C. 2. Price 20s. net.

Repairing of Locomotives. No. III.: Tools and Appliances Useful in the Repair of Boilers, Boiler Fittings and Accessories. By E. L. Ahrons. London: The Locomotive Publishing Company, Limited, 3, Amen-corner, E.C. 4. Price 2s. 6d. net.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—The annual dinner of the Institution of Electrical Engineers was held at the Hotel Cecil, on Tuesday, February 6th, when the President, Mr. Frank Gill, of the Western Electric Company, presided over a large gathering of members and guests. Messages of greeting were read from the American Institute of Electrical Engineers, the French Society of Electricians and the Italian Electro-Technical Association. The chairman also read a communication from the Prince of Wales, regretting his inability to be present on account of the overwhelming number of invitations he had received for the present year, but intimating that he might be able to attend the Institution's dinner on another occasion. In submitting the toast of "The Institution," Sir W. Joynson-Hicks referred to the importance of research, and pointed out that it was by the development of science and commercial improvements that the trade of this country was extended in the past, and would be developed in the future. In replying to the toast, the chairman referred to the subject of his presidential address, namely, "International Telephony in Europe," and said that the only way of tackling the problem was to arrange for unity of control for the whole of the through business. The toast "Our Guests" was proposed by Mr. J. S. Highfield, and was responded to by the Postmaster-General, the Right Hon. Neville Chamberlain. Sir Arthur Colefax also responded. To enable the speeches to be clearly heard in all parts of the room the Western Electric Company's public address system was installed, particulars of which will be found at the end of our recent article on the "Year's Progress in Electrical Engineering."

A New Condenser Extraction Pump.

WITH the increasing use of high vacua for steam turbine installations, and more especially with the introduction of the closed feed system, it has become necessary to employ every possible means of eliminating air leakage and the presence of dissolved gases in the system. Modern condensing plant practice has shown that a frequent source of air leakage is that which takes place through the glands of the condensate pump. Apart from the risk of reduced vacuum and lower efficiency arising from this cause, difficulty has often been met with in keeping glands and pump shafts in good condition, since if the glands are

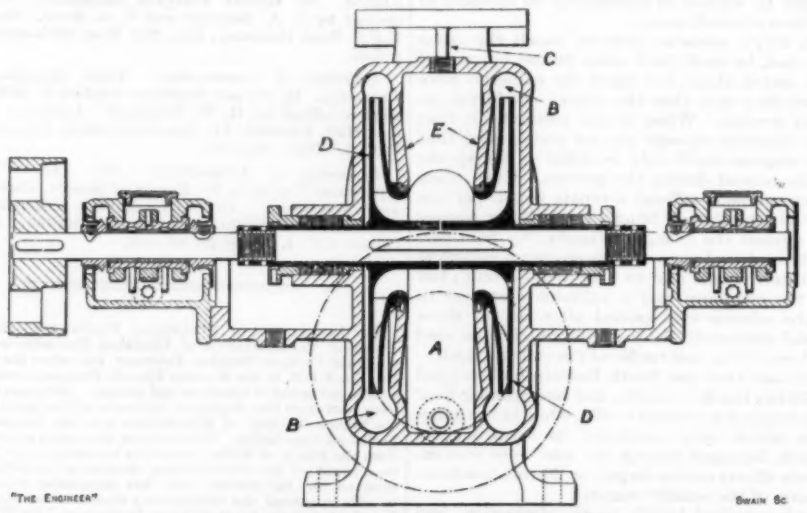


EXTRACTION PUMP WITH GLANDS UNDER PRESSURE

tightened to reduce leakage there is always a possibility of over-tightening, with the result that the shaft becomes scored.

It is not surprising, therefore to learn that a well-known firm of condensing plant engineers has sought to obviate these deficiencies by designing a new form of pump. We illustrate above a new patented type of high-vacuum centrifugal extraction pump which has recently been placed on the market by the Mirrlees Watson Company, Limited, and which will form, we understand, one of the integral units of the Mirrlees closed-feed system. As will be noted from the illustration, the pump is substantial in build, and the casing is split horizontally, which facilitates the inspection of the working parts without disturbing the alignment of the pump and motor.

The chief feature of the new design is the elimination of all air leakage through the gland and stuffing-boxes by placing these parts under a pressure corresponding to the external head against which the pump is working. A section of the pump is reproduced below, and serves to show the impeller arrangement and the general details



SECTION THROUGH CONDENSER EXTRACTION PUMP

of the design. Two single suction impellers are mounted on opposite sides of the pump suction A, and are so arranged that their inlets are facing each other, and the impellers discharge into volutes or pressure chambers B. These volutes are interconnected and join up to the common discharge pipe C. It will be noted that the two impellers work in parallel, their disposition being such that the end thrust of the one is counterbalanced by the end thrust of the other. The chambers D at the opposite ends of the pump casing communicate with the inner ends of the stuffing-boxes through which the impeller shaft passes, and are also connected with the volutes by means of the clearance spaces at the peripheries of the impellers Any possible communication between the chambers D and the suction inlet A is prevented by the impellers and the diaphragms E. The pressure in the chambers D therefore corresponds to the discharge head against which the pumps are called upon to work, and as this is well above the pressure of the atmosphere there is no tendency for air to enter the pump casing through the stuffing-boxes. As the design is intended for moderate discharge heads, the glands do not require to be very tight in order to prevent leakage.

We understand that the power required to drive the pump compares very favourably with that needed by other pumps for similar work. The impellers are dynamically and statically balanced, and the steel shaft is entirely protected by means of a renewable bronze liner. Among other advantages of the new pump is the elimination of water sealing, with the attendant pipe connections and lantern rings in the stuffing-boxes. The plain stuffing-boxes are more easily packed, and as the pressure is outwards the hot condensate is not contaminated by the infiltration of oil and grease. The type of pump we have described is for a surface condenser, but the design may also be applied to extraction pumps for jet condensers.

Oil Engine Nomenclature.

THE Institution of Mechanical Engineers has now issued the report of the Committee on Oil Engine Nomenclature. We reprint it in full below :—

Constitution.—During the discussion arising at the Lincoln summer meeting in 1920, on the paper by Mr. F. H. Livens, entitled "Some Lincolnshire Oil Engines," a number of members commented upon the prior claims of Mr. Herbert Akroyd-Stuart to be acknowledged as the pioneer of the modern heavy oil engine and as to the inadmissibility of the term "semi-Diesel" to describe the type of engine developed from his invention. In his concluding remarks the president, Captain H. Riall Sankey, C.B., C.B.E., announced his intention of suggesting to the Council that a Nomenclature Committee be established for oil engines "to deal with the question generally."

The Council duly appointed such a Committee "To consider the Nomenclature for Oil Engines" and nominated the following members to serve thereon, "with power to add to their number" :—

Captain H. Riall Sankey, C.B., C.B.E., President (Chairman).
Mr. F. H. Livens, Member of Council (Deputy Chairman).
Mr. A. E. L. Chorlton, C.B.E., Member of Council.
Mr. Loughnan Pendred, Member of Council.
Mr. William Reavell, Member of Council.
Professor William Robinson.
Mr. W. A. Tookey.

The following subsequently accepted invitations to serve on the Committee :—

Brig.-Gen. R. K. Bagnall-Wild, C.M.G., R.A.F. (Aeronautical Inspection Directorate).
Mr. Charles Day, Member of Council.
Lieut.-Col. L. F. R. Fell, D.S.O., O.B.E., R.A.F. (Directorate of Research, Air Ministry.)
Eng. Vice-Admiral Sir George G. Goodwin, K.C.B., LL.D., R.N. (Engineer-in-Chief of the Fleet, since retired).
Eng. Commr. C. J. Hawkes, R.N. (ret.) (Professor of Engineering, Armstrong College).
Dr. F. W. Lanchester (representing the Institution of Automobile Engineers).
Mr. E. W. Petter, Member of Council.
Mr. Geoffrey Porter (representing the Diesel Engine Users' Association).
Mr. C. G. Roberton (representing Vickers Limited, since deceased).

Five meetings in all have been held apart from the work of a Sub-Committee consisting of Messrs. Chorlton and Tookey.

REPORT.

1.—The Committee has given consideration to various suggestions and schemes of nomenclature emanating from the Chairman, individual members and from its Sub-Committee ; to correspondence and pamphlets addressed to it by Mr. Herbert Akroyd-Stuart ; to *dossiers* submitted by the Admiralty and the Department of Scientific and Industrial Research ; to representations from the British Engineering Standards Association ; and to replies to inquiries, made on its behalf by Mr. Pendred, as to the existence or otherwise of approved nomenclature of oil engines by engineering institutions in France and in the United States of America.

2.—The Committee is of the opinion that the modern oil engine, as distinct from the automobile type of liquid fuel engine, has been evolved mainly from the principles enunciated by Mr. Herbert Akroyd-Stuart in his Patent No. 7146 of May 8th, 1890, and, as embodied in the engine constructed at Bletchley, Buckinghamshire, and tested by Professor William Robinson, a member of the Committee, in February, 1891. Professor Robinson referred to this engine in detail in a paper, "The Uses of Petroleum in Prime Movers," read on April 29th, 1891, and subsequently published in the *Journal* of the Society of Arts. This "Akroyd" engine is the prototype of those in which the liquid fuel is introduced into a compressed or partially compressed charge of air, and which do not need an extraneous source of ignition. In this respect the "Akroyd" engine anticipated the engine subsequently evolved in Augsburg, Germany, by the Maschinenfabrik Augsburg Nürnberg from the original proposals of Rudolph Diesel in 1893 and described by H. Ade Clark in his paper, "The Diesel Engine," read before the Institution at the meeting in Leeds in July, 1903. It may thus be said that the pioneer work of Herbert Akroyd-Stuart has been adversely cloaked by nomenclature.

3.—In the development of modern oil engines, departures have been made both from the "Akroyd" and the "Diesel" original principles, and to designate these by inventors' names would be misleading and depreciative of the work of those to whose efforts the recent successes achieved have been due. The various types of engines merge so intricately that arbitrary grouping for the purposes of nomenclature would be unsatisfactory. For commercial exploitation trade names cannot be dispensed with, and, after all, these are usually sufficiently distinctive for general use.

4.—The Committee considers that the term "semi-Diesel" as applied to oil engines is subversive of the fact that this type of oil engine is a British production and an evolution from the "Akroyd" engine.

5.—After careful consideration the Committee has been forced to the conclusion that an extended classification would be of little value, and that it is improbable that any system of nomenclature could be devised to cover all divergent points of detail and to meet practical requirements.

EDUCATIONAL INTELLIGENCE.

THE following special course of lectures on "Copper and its Alloys" will be given at the Sir John Cass Technical Institute, Jewry-street, Aldgate, E.C. 3, during the Lent Term, 1923 :—Wednesday, February 14th, at 6.30 p.m.: Inaugural lecture, "Some Modern Developments in the Industry," by Professor C. H. Desch, D.Sc. (Lond.), Ph.D. (Wurz.). The chair will be taken by Mr. C. T. Heycock, M.A. (Cantab.), F.R.S., Prime Warden of the Worshipful Company of Goldsmiths. Wednesday, February 21st, at 6.30 p.m.: "Foundry Practice as related to Copper Alloys," by H. S. Primrose. Wednesday, February 28th, at 6.30 p.m.: "Large Metallic Crystals," by Professor H. C. H. Carpenter, M.A. (Oxon.), Ph.D. (Leip.), A.R.S.M., F.R.S. Wednesday, March 14th, at 6.30 p.m.: "Corrosion," by Guy D. Bengough, M.A. (Cantab.), D.Sc. (Liverpool). Wednesday, March 21st, at 6.30 p.m.: "Season Cracking and Heat Treatment," by Harold Moore, D.Sc. (Lond.), Ph.D. (Lond.). Fee for those resident in the administrative county of London and in the county of Middlesex, 10s. An extra charge is made to students who live outside the administrative county of London, except those living in Middlesex. Students under eighteen years of age are admitted at half fees.

An Electric Runabout Crane.

A VERY successful demonstration of the capabilities of the latest Ransome runabout electric crane took place at the works of Ransomes, Sims and Jefferies, Limited, on Monday, February 5th. The crane, which is shown in Fig. 1, is constructed on a novel principle, and it travels, hoists and derricks with power supplied from a storage battery consisting of twenty cells of 258 ampère-hour capacity, or alternatively from a battery consisting of forty cells with a capacity of 129 ampère-hours. The particular crane which we saw in operation was designed ordinary type, but with this design it was necessary, in order to obtain the requisite stability in every position of the jib, to provide a large base, and the construction must be sufficiently heavy to stand the stress set up when the load is slewed round by the crane relatively to the road wheels. In some positions, moreover, practically all the load is thrown on one of the wheels, and this may set up an abnormal pressure on the ground upon which the crane is working. As a result of these difficulties, the makers explain, it has been customary in the past to provide sprags, which can be dropped in order to stabilise the vehicle whilst the crane is at work, but this scheme, it is explained, limits the utility of the vehicle by depriving it of its mobility while the sprags are in use.

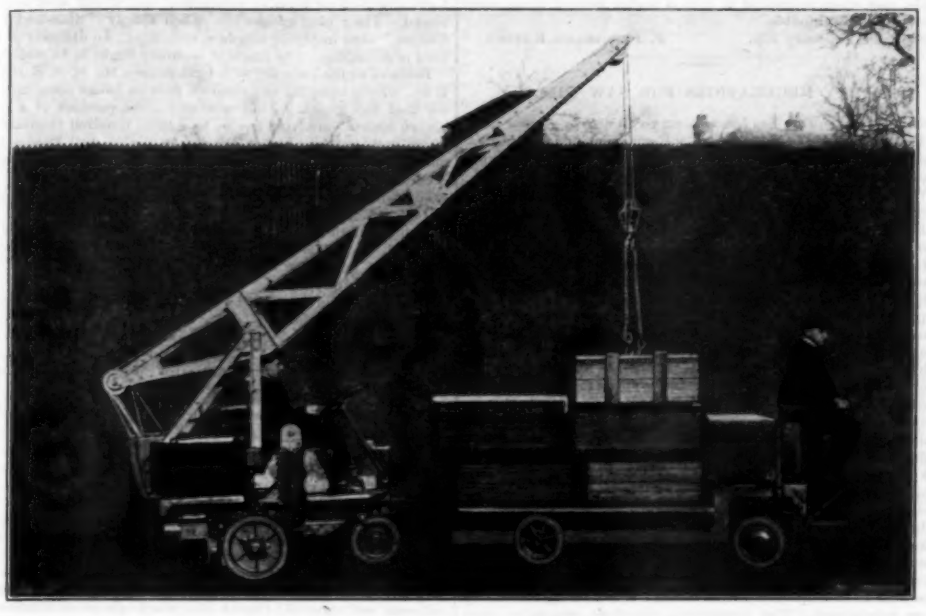


FIG. 1—ELECTRIC RUNABOUT CRANE LIFTING LOAD

to deal with a load of 15 cwt., but the firm is also manufacturing 7½ cwt. and 20 cwt. cranes of this type.

The first demonstration took place in the garage of the Ipswich works, where the crane was made to travel backwards and forwards, to derrick the jib, and to hoist and lower moving loads, and subsequently other interesting demonstrations were given. The crane was shown, for example, taking logs from a timber trolley to a timber stack, and was also made to lift cast iron bed-plates on to a Stirk planing machine, and to remove a crank shaft weighing approximately 15 cwt. from a Ransomes electric truck, and to place it in position in a lathe. The bed-plate and crank shaft were also removed from the machines. All these operations were carried out with perfect ease, and demonstrated in a very striking manner the great advantages of a crane of this type in engineering works.

After the crane had undergone these tests it was made

In the design of the crane under consideration, for which Mr. P. A. Mossay, of Mossay and Co., is responsible, steps have been taken to overcome these limitations and objections. The turn-table, which is usually employed to enable the crane to swivel independently of the chassis frame, is dispensed with, the crane being rigidly fixed to the chassis of the vehicle, which is designed so as to be able to turn on its own axis or to run forwards or backwards in a path of any curvature. As the crane is a fixture on the chassis, the jib is always in the same position relatively to the chassis, with the result that there is no variation in the stability factor as the load is slewed. The weight of this runabout crane is therefore considerably less than that of a crane truck built on orthodox lines for the same capacity, whilst the pressure on the road or floor also remains constant for all positions of the crane, and is reduced to a low value by distributing it between four

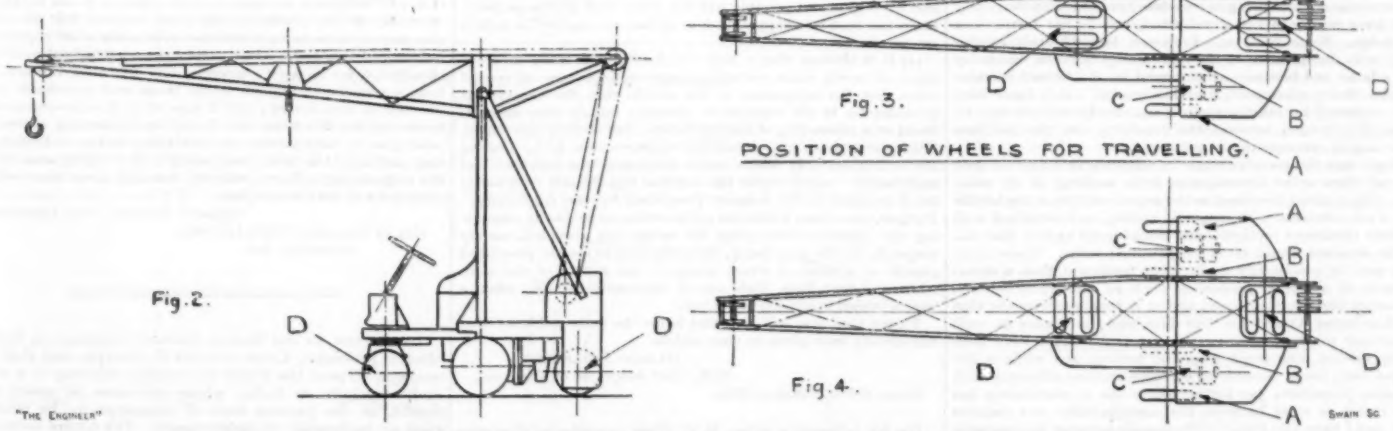
by the steering mechanism causes the motors to rotate in opposite directions as soon as the power is switched on by the movement of the controller, with the result that slewing occurs.

On the right of the driver's seat the hoisting and derricking controller is placed, and it is operated by a single lever working in a gate.

To hoist or lower the load the lever is moved forwards or backwards on one side of the gate, whilst similar movements on the other side of the gate cause the jib to be raised or lowered. It is also possible to lower loads by gravity without energising the motor, but the load is nevertheless under perfect control. The hoisting and derricking motions are obtained by means of a single motor which rotates the respective rope barrels by means of high-efficiency worm and spur gearing, the drive being by means of a patented mechanism which gives simple control whilst also giving high efficiency and safe braking. The mechanism consists of an arrangement of Ferodo-lined friction clutches and brakes, which are designed so that when it is desired to operate either of the motions the brake by which the load is normally secured is progressively released as the clutch is applied, and *vice versâ*, the brake being progressively applied as the motion is stopped by the withdrawal of the clutch. In addition to giving sweet and simple control, the arrangement presents the advantage that notwithstanding that the motor serves for either the hoisting or derricking motion, it is automatically started and stopped as the clutching operations are performed, with the result that less energy is consumed than would be necessary if the motor were left running.

This mechanical progressive braking system also obviates the employment of electric brakes, which, in the case of a single motor operating two distinct motions, would require special switching arrangements. Moreover, as the driver can control all the motions of the crane from his seat, and as he has a clear and uninterrupted view of the load, the operations of simultaneously travelling and hoisting, travelling and derricking, slewing and hoisting, or slewing and derricking, can be carried out with perfect ease.

The battery which supplies the power for all the operations is contained in two boxes, which can readily be removed, and they are placed in a position on the chassis which makes them serve as counterweights. When desired, a duplicate battery is provided so that one battery can be charged whilst the other remains in service. It is obvious that cranes of this type can be used for a large number of purposes. They have been tested for a period of seven months by various dock and harbour authorities and railway companies, and also in engineering works, timber yards, &c., and the results obtained are said to have been satisfactory in every instance. The use of these electric cranes has resulted in the saving of a considerable amount of time and labour, and there does not seem to be much doubt that sooner or later electric runabout cranes will be widely used in this country.



FIGS. 2-4—SIDE ELEVATION AND PLANS OF ELECTRIC RUNABOUT CRANE

to travel a quarter of a mile along the dock side, where rails are laid, and where in places the ground is very uneven, but notwithstanding these adverse conditions the crane covered the journey without difficulty. Having arrived at the ship launch road, loaded cases were lifted from a Ransomes electric lorry into a railway truck, each case weighing approximately 12½ cwt. Here, again, the crane performed its work with all the ease that could be desired, and there seems to be no doubt whatever that the crane fills a long felt want. It can be manœuvred in confined places and tortuous passages, and it can run through doorways of warehouses and workshops, or it may be placed alongside motor lorries or railway trucks that have to be loaded and unloaded in the shortest possible time.

It has been customary in the past, the makers point out, to mount a swivelling crane on a motor vehicle of the

pairs of wheels. A powerful foot brake is provided for use in regulating the motion of the crane, either when slewing or when moving from one point to another.

The construction of the crane will be understood from the drawings, Figs. 2, 3, and 4, the two latter drawings showing the positions of the wheels for travelling and slewing respectively. The front and back pairs of wheels D D form the steering wheels, and are both operated from the steering gear, whilst the two pairs of wheels A B do not swivel, the outer wheels A being driven through reduction gear by electric motors C, which are spring supported. The travelling and slewing controller is placed on the left of the driver's seat, but slewing can only take place when the wheels D D at each end of the chassis have been moved into a position at right angles to the driving wheels A, and in this position an electrical contactor gear which is brought into operation automatically

SOUTH AFRICA'S NEW HARBOUR.

AT the meeting of the House of Assembly at Capetown, on January 25th, Mr. Jagger, Minister of Railways, made an important statement regarding the proposed new harbour on the Zululand coast. Asked whether a report had been received from Sir George Buchanan on the question, the Minister replied in the affirmative, and declared that flying surveys had been made of alternative railway connections to such a port. Mr. Jagger added that details of the engineering and other investigations

would not be published until the Government could submit to Parliament complete and final reports of the estimates, together with the report of the Railway Board. Naturally further surveys and borings would be necessary, and arrangements for this work would be undertaken during the winter. Sir George Buchanan's report was, he continued, extremely favourable. The construction of a harbour would be practicable at Kosibay or Mbangenek or Sordwana Bay, but Sordwana Bay was most favourably reported upon as being the locality where the cheapest port could be made in the shortest possible time. Sir George Buchanan reported that he was considerably impressed by the prospects of making a really first-class port there at reasonable cost. There was ample accommodation, and a plan could be prepared for progressive construction with the object of making a great port in the future with a good lay-out. Mr. Jagger concluded

by stating that Sir George Buchanan believed it possible to ship coal faster and more cheaply at Sordwana Bay than at Delagoa Bay, and the new port must consequently take the bulk of the Delagoa Bay coal trade, and would do so on its own merits because the cost of shipping would be so much less. The examination of railway connections showed that a railway could be constructed at a relatively moderate cost which would be superior in gradients and operating advantages to any of the existing routes to the sea board.

THE NEWCOMEN SOCIETY—CALICO PRINTING.

IN pursuance of its policy to take within its purview the history of all branches of technology, the Newcomen Society on Wednesday evening listened to an admirable lecture on "Oriental Cotton Printing in the Sixteenth and Seventeenth Centuries." The lecturer was Mr. G. Baker, of the Cray Calico Printing Works, and the owner of the finest collection in the world of oriental-printed calicos. The meeting was held in the hall of the Alpine Club, Saville-row, the walls of which were hung with priceless examples drawn from Mr. Baker's collection. The lecturer explained in detail the method followed by Indian cotton printers, and remarked that the industry had now been wholly lost. It appeared to have begun in or about 1630, and to have ceased in 1750. Both in design and execution the work was extraordinarily beautiful. Although called printing, the work was not printing in the ordinary sense of the word, for blocks were but rarely used. It was rather a process of selective dyeing carried out by means of "mordants" and "resists." In essence it was similar to cotton printing of to-day, save that blocks were rarely used, and that all the work was done by hand. As an example of the exclusiveness of certain trades, it may be mentioned that in the period under review the dyeing with indigo was a separate craft. Indigo dyers would handle no other colour. In the course of his lecture, Mr. Baker briefly described a huge machine recently put into use by his firm. It has a printing cylinder 12ft. in diameter, and as many as sixteen colours can be printed at once. The lecturer attributed the loss of the Indian industry to the apathy of the British Government. An effort to revive it was being made by a few students in Madras.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

RESEARCH IN CUTTING TOOLS.

SIR,—The report of the Lathe Tools Research Committee of the Manchester Association of Engineers, referred to in a leading article of your issue of the 26th ult., will, I am afraid, do far more harm than good, as investigators may be turned from useful lines of research if they accept the erroneous conclusions contained therein. The authors of the report did not obtain any greater consistency with their heat treatment than previous investigators, but by the astounding step of taking the constant $V T^{\frac{1}{4}}$ as a measure of the tool's performance, the inconsistency of their results has been made much less apparent. In the text on page 11, it is mentioned that at a constant cutting speed, variations of from 18¼ to 36 minutes were found, and yet a consideration of Table No. 1, Trials Nos. 2 and 5, for two tools giving durations of run of 40 min. 37 sec. and 17 min. 43 sec. respectively at speeds differing only by one-tenth per cent., shows that the report seriously suggests that the relative durabilities were 156.8 and 141.4 respectively. This unfortunate adoption of the $V T^{1/n}$ formula throughout the report has given the results recorded an appearance of consistency, which the heat treatment methods described could never be expected to give.

The results endeavouring to correlate hardness with durability could have well been left unpublished, and do not further our knowledge. Some years ago Professor Arnold* dealt conclusively with the question of the relationship between durability on the lathe and hardness as measured by the Brinell machine and the Shore scleroscope, and his results, which have been fully confirmed by other investigators, clearly showed that no relationship existed between the durability and the hardness of the tool at atmospheric temperatures.

I hope that the remarks made in reference to magnetic tests will not deter other investigators from working in the same field. The method described in the report exhibits a deplorable lack of acquaintance with magnetic testing, and combined with the heat treatment methods, one would quite expect that the results obtained would be of no practical value. There is no surer test for consistency during heat treatment than a determination of magnetic properties, such as saturation density, remanence and coercive force, and it is most unfortunate that the Manchester Committee has dismissed the matter in such a summary manner. During the last two years I have been closely related with much magnetic testing, and while it has not yet been found possible to correlate cutting efficiency with magnetic properties, yet for certain steels a relationship has been found to exist between the machinability and coercive force, and I have also found a relationship between the magnetic and some mechanical properties of certain nickel chromium steels.†

The description of the removal of a chip on page 67 is very incomplete, if not actually inaccurate. During the discussion on Professor Coker's and Dr. Chakko's paper,‡ I dealt briefly with the phenomena of cutting, and I am surprised at the Manchester Engineers making no mention of the built-up cutting edge, which I then described and which is a well-known phenomenon to many.§ It appears that the cutting edge itself, when cutting has once started, has practically only one function, which is to support another cutting edge built up from particles scraped off the material being cut. When a tool has run so long that it will no longer cut, little, if anything, can be learned from its examination, because as soon as breakdown occurs, the whole of the cutting edge is absolutely destroyed. If, however, cutting operations are suspended while the tool is still cutting, it is found that wear has always commenced some distance behind the cutting edge, and that the edge remains protected by a superimposed built-up cutting edge.

Finally, the report ends with a short paragraph under the heading "Material operated upon." Surely the authors of the report must know that Brinell hardness is no criterion of machinability, even when considering steels of the same composition? During the last few years, numerous batches of material have come under my notice which were very severe upon tools, and when re-treated to give a higher Brinell figure were more easily machinable.

Sheffield, February 5th. J. FERDINAND KAYSER.

* Arnold, "Note on the Relations between the Cutting Efficiences of Tool Steels and their Brinell or Scleroscope Hardness," *Journal*, I. and S. Inst., 1916, No. 1.

† Discussion on "Temper Brittleness" papers, *Journal*, I. and S. Inst., 1920, No. 1, page 623.

‡ Discussion on "Action of Cutting Tools," "Proc.," Inst. of Mech. Engineers, May 2nd, 1922, pages 613 and 617.

§ Burley, "Cutting Power of Lathe Tools," "Proc.," Inst. of Mech. Engineers, December, 1919, page 760.

SAFETY REGULATIONS FOR SAW MILLS.

SIR,—My attention has been drawn to an article in your issue of December 29th, entitled "Safety Regulations for Saw Mills," which criticises adversely the recently issued wood-working regulations.

While I do not desire to deal with these criticisms seriatim, there are one or two statements which, in view of the wide publicity enjoyed by your journal, it is felt ought not to be allowed to pass unchallenged.

(1) The article states: ". . . it becomes clear that those who have framed these regulations have but a superficial knowledge of the real dangers of wood-working machines." This is apparently intended as a criticism of the factory inspectorate, who, in spite of wide experience gained over a long series of years, are presumed to have but a slight acquaintance with the subject. In point of fact, the regulations are based on detailed proposals drawn up by the Safety and Welfare Committee of the Building Trades Joint Industrial Council, on which both employers and operatives were represented. This Committee took the advice of representatives of the furniture trade and saw mill industries, and also of manufacturers of wood-working machinery. Its proposals were accepted unanimously by the whole Council, which presented them to the Home Office for embodiment in a code of regulations. The regulations thus framed were formally submitted in draft to the principal associations of employers and operatives, and after being amended in consultation with the Committee to meet particular objections, were finally accepted as an agreed code at a meeting at which the most important associations of employers interested in wood-working machinery were represented. The regulations, therefore, emanated from the industries chiefly concerned, and these industries were consulted at every step in the course of their preparation and issue.

(2) The regulations are criticised on the grounds that they apply only to certain machines and fail to deal with other machines which are regarded by the writer of your article as being more dangerous. The reason why certain machines are not included in the regulations is simply that they were not dealt with in the recommendations of the Committee. This does not mean that they are not subject to any regulation. The general requirement in the Factory Act that all dangerous machinery must be securely fenced applies, but the occupier, instead of being required to make use of prescribed safeguards, is left free to adopt such guards as are most suitable in the circumstances.

(3) I must take strong exception to the statement that "Perhaps the most incomprehensible of these regulations . . . is that which renders it compulsory to place circular cutter blocks on all hand-feed and 'over and under' planing machines. It is said that this extraordinary measure has been taken owing to a totally erroneous impression that the circular cutter block is less dangerous than the square block." It is true that this regulation has been made because it is believed that the circular block is less dangerous than the square one, but that belief is founded on no "erroneous impression," but upon actual experience. Accidents may occur with either type of block, but the experience of the Factory Department shows that whereas with a square block a man is almost certain to lose his fingers and possibly half his hand, with a circular block the worst that can happen to him is that the tips of his fingers are pared off.

(4) It is obvious that a code which affects so many different types of works must contain exceptions in favour of special cases, but the suggestion in the article that the exemptions provided for in the regulations virtually nullify their effect is based on a misreading of the regulations, and is quite unjustified. Exemptions from the prescribed requirements as to fencing are authorised only where other safeguards are provided and maintained "which render the machine equally safe as it would be if guarded in the manner prescribed by the regulations." Further, the clause which the article refers to as totally exempting the operator from using the safeguards provided, merely suspends, for the time being, the obligation to use the prescribed guards or appliances when, owing to the nature of the work which is being done, their use is impracticable, *e.g.*, when a saw is buried in the log being cut.

I trust that you will give this letter the same publicity that has already been given to your article.

GERALD BELLHOUSE,
H.M. Chief Inspector of Factories.

Home Office, January 30th.

[In his interesting letter, H.M. Chief Inspector of Factories points out that the regulations were submitted to and presumably approved by the associations representing both employers and operatives. The effect of this influence is, in fact, self-evident in those clauses of the regulations which we still consider nullify in great measure some of the precautions ostensibly provided by the regulations. We quote the following from the Chief Inspector's communication: "The clause which the article refers to as totally exempting the operator from using the safeguards provided, merely suspends, for the time being, the obligation to use the prescribed safeguards on appliances when, owing to the nature of the work which is being done, their use is impracticable—*e.g.*, when a saw is buried in the cut." If that is really so, what is the meaning of the clause? Why, if a man cannot by any conceivable possibility make use of a guard, is it necessary to frame a regulation which gives him an option of using it or not? With regard to the Chief Inspector's views of the safety of the so-called "safety cutter block," we publish in another column an article by a well-known saw mill engineer, which explains this matter very thoroughly.—ED. THE E.]

MADE *versus* PURCHASED GAUGES.

SIR,—Recent letters in your columns discussed the question of the accuracy of plug gauges, and a statement, made by Mr. A. C. Wickman, that these gauges were not as accurate as is generally supposed, met with little effective contradiction. The remarks made were, however, intended to apply only to gauges made by works for their own use.

It was noteworthy, however, that no makers of gauges for sale wrote stating the accuracy to which their product was made, and the accuracy of the bought gauge is thus called into question as much as that of the "home-made" one.

The general impression which sellers of gauges wish to create is that if you purchase a standard 1in. gauge, then it *is* 1in. exactly, and not plus or minus anything. I write with the recent catalogue of a well-known gauge-making concern before me, and I observe that no limit or guaranteed size of any kind is mentioned. Their plug gauges are called simply "Standard Plug Gauges," thus implying absolute accuracy. An attitude of this kind is ridiculous. The limits of accuracy ought to be stated.

Relative to the accuracy of bought gauges, Mr. M. R. Barnsley, B.Sc., who is carrying out research here on gauge sizes, informs me that the gauges in our workshop—the product of a well-known maker—are from twelve to sixteen hundred thousandths of an inch out in parallel alone. It is also well known that many works make their own gauges because they are more accurate than those purchased outside would be. Thus the exemption of purchased gauges from criticism does not appear to be warranted.

In my opinion, every gauge sold as a standard should have the actual size as well as the nominal size marked upon it, and should carry some guarantee that the measurement of the actual size has been carefully made.

It would be interesting to hear the views of purchasers of gauges on these matters. I have a strong notion that stock gauges as offered at present are not exactly what is required, and that a cheap gauge, not quite so supposedly accurate as now offered, but of definitely stated error, would fulfil a want in many small and medium-sized shops.

HY. BAKER.

University of Birmingham, February 6th.

RAILWAY ELECTRIFICATION.

SIR,—My attention has been drawn to your very interesting leading article on the question of "Electrification of Trunk Line Railways," in which you refer to the significant question of using standard 50-cycle single-phase alternating current as the medium of transmission of energy. It is quite true that certain railways are using 15, 16 and 25-cycle single-phase alternating current, and that in the ordinary way it is very difficult to design satisfactory electric motors to operate on 50-cycle current, and at the same time to meet properly the severe duty of, say, mountain grade duty.

As you rightly say, it is perhaps a very good thing under the circumstances that this country is so much behind the times in regard to railway electrification, because it is very obvious that millions of much wanted capital is about to be simply squandered in direct-current electrification to suit the whims and pockets of a few interested firms and individuals.

It is simply surprising to see the Government spending the country's capital to provide dividends for a whole tribe of "Electrical White Elephants," in the form of Early Victorian direct-current electrification. The whole thing is out of date, besides being a danger to the travelling public and railway workmen. You have rightly raised a question which should be investigated very closely in the public interest.

WILLIAM P. DURTNALL.

London, S.W. 1, February 6th.

CATALOGUES AND PUBLIC LIBRARIES.

SIR,—For some time past I have been endeavouring to bring together a representative collection of trade catalogues of the engineering industry for the use of students in this city. Most of your advertisers and subscribers will doubtless have received my printed application during the past six months; but I hope that you will grant me space in your columns to ask for the co-operation of your readers in this work, in order that the collection may be made as representative as possible of the engineering industry in England. These catalogues are arranged in strictly classified order in our Commercial and Technical Library, and form a very useful adjunct to the books and periodicals which are filed in that library; and I hope that all representatives of firms that see this letter will favour me by sending a complete catalogue of their productions for filing in this collection. I may add that the collection, which is not wholly confined to the engineering industry, already contains some thousands of catalogues of very recent date.

CHARLES NOWELL, City Librarian.

City of Coventry Public Libraries,
February, 3rd.

LECTURING to the Indian Science Congress on hydro-electric problems, Lieut.-Colonel B. Battye, said that the coal age all over the world was rapidly drawing to a close, and especially in India, whose resources in steam coal would, at the present rate of consumption, be entirely used up in seventy or eighty years. The future economic stability of the country entirely depended upon development of water power, and in Northern India that hinged upon the development of the Himalayan rivers. Available markets for power in Northern India were not as yet sufficiently concentrated to justify the development of separate projects for each industrial area unless the rivers could be developed by using the comparatively expensive low falls available. This left two alternatives—either the development of large national projects, serving thirty or more towns, entailing widespread transmission, large initial capital and consequently nationalisation, or else the adoption of low-fall schemes in each locality. Hydro-electrical development problems in India were in the main administrative and political rather than technical. Large amounts of capital such as at present appeared to be beyond the resources of the provinces would have to be found, and these could only be got by resort to Western capitalists, who would be prepared to find the capital only if a safe return was guaranteed.

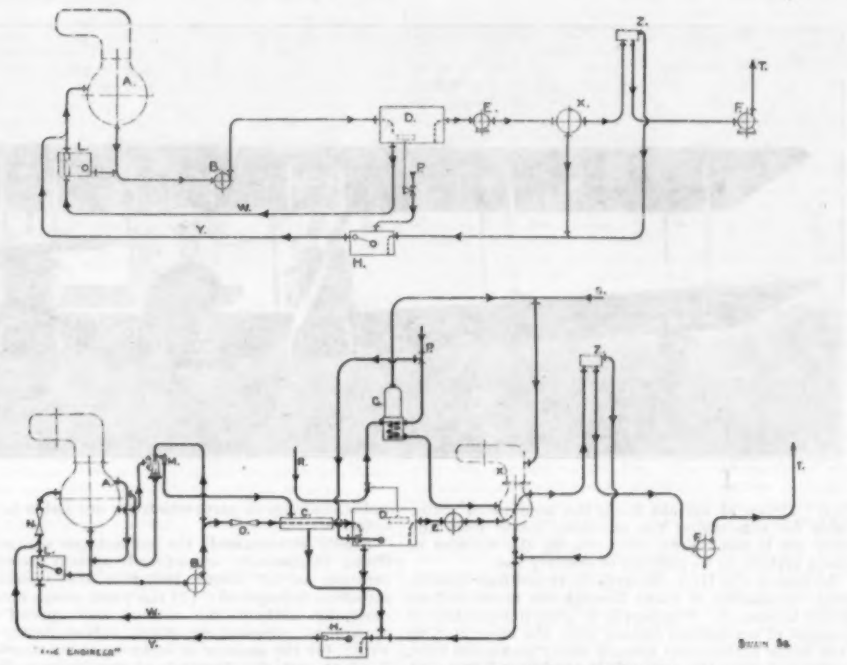
A New Closed Feed System.

THE importance of de-aerating boiler feed water is now well appreciated by power station engineers. Exhaustive experiments have shown that water which has been freed from air or de-aerated is very much less liable to give rise to corrosion than water in its usual state, and consequently more suitable for boiler feed purposes. The adoption of high-pressure steam in modern power stations has called for the provision of economisers fitted with steel tubes and the use of wrought steel feed-water piping, with the result that it has become more desirable than ever that the feed water should be de-aerated.

With a view to overcoming corrosive troubles the so-called closed-feed system has been introduced, and one of the firms which has recently put forward a system of this nature is Hick, Hargreaves and Co., Limited, of Soho Works, Bolton. Briefly, the closed-feed system consists of feed piping and auxiliaries which are arranged so that only de-aerated water is supplied to the economisers and boilers. Hitherto, the makers of this new system contend, closed-feed systems have proved difficult to adjust and a source of anxiety to the operating staff, but the system under consideration is claimed to be free from those drawbacks, and to be the simplest that has been introduced, for it is purely mechanical, automatic in action, and can readily be understood by the operating staff. For the removal of the oxygen no oxidising material is used, its removal being accomplished mechanically by the air extractor on the main condenser. The re-charging of vessels with oxidising materials is entirely avoided, and uniform results are secured. Another advantage claimed is that special automatic apparatus such as pressure regulating valves are unnecessary.

A diagram of the Hick, Hargreaves system is shown in Fig. 1. Condensate is withdrawn from the main condenser A by an extraction pump B, and is discharged into a steam-sealed tank D from which the lift pump E takes its supply of water and discharges it through a feed heater or house turbine condenser X to the suction of the feed pump F. As it is necessary to provide a head of water at the suction branch of the feed pump, a closed tank Z is placed in an elevated position, and an overflow is taken from this tank and is connected to the auxiliary tank H. The make-up supply is also taken to this tank and is under the control of a float, which is actuated by the rise and fall of the water in the main feed tank D. The water in the auxiliary tank H is passed into the main condenser A by a pipe Y controlled by a float valve which is opened as the float rises, thus disposing of any water that may collect in the auxiliary tank and ensuring that the make-up supply is de-aerated in the main condenser.

To ensure that the extraction pump B is fully charged with condensate and stabilised under all conditions of load on the main unit, a pipe W is connected from the feed tank heater may be placed between the latter and the lift pump discharge, so that the heat in the drips is given up to the boiler feed instead of being lost in the circulating water of the main unit. This arrangement, the makers point out, adds to the thermal efficiency of the closed-feed system, and assists in securing a satisfactory heat balance.



FIGS. 1 AND 2—ARRANGEMENT OF CLOSED FEED SYSTEM

The system operates in the following manner:—Assuming that the amount of condensate from the main condenser A to be less than that required by the boiler-house, on account of the fact that the generating units are underloaded, the amount of feed required will be provided from the main feed tank D, in which there is an ample supply of water for the lift pump E to draw from. Under these conditions the float in the chamber L will fall and will thus allow an increased supply of water to pass from the tanks D along the pipe W into the condenser and thence to the suction side of the extraction pump B, with the result that the latter is kept fully charged and its operation is stabilised. If the demand of the boiler-house continues to be in excess of the amount of condensate discharged from the main condenser, the level of the water in the tank D will fall, thereby lowering the float controlling the make-up supply valve and admitting an increased supply of make-up water to the system.

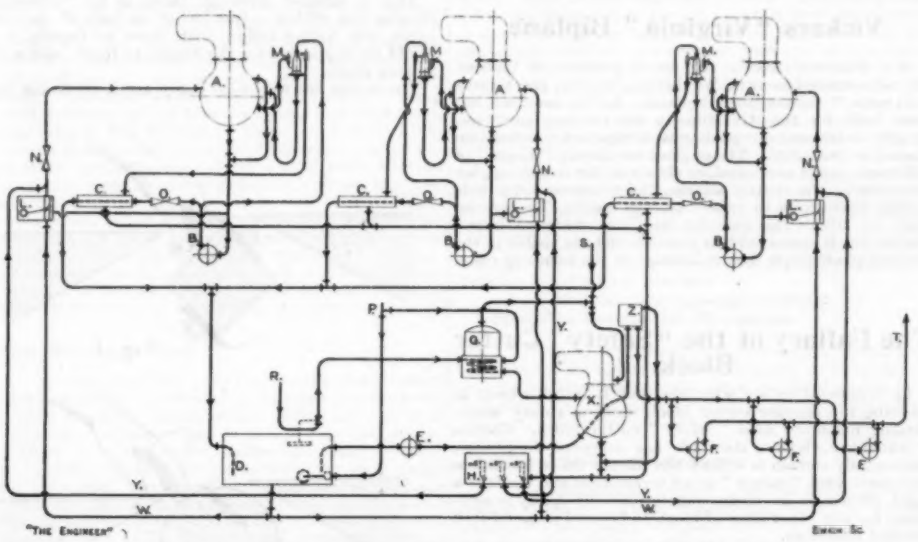


FIG. 3—CLOSED FEED SYSTEM APPLIED TO THREE TURBINES

This supply of water passes along the pipe Y into the main condenser, where it is de-aerated and afterwards withdrawn by the extraction pump B, thus making up the deficiency due to the extra amount of water which is withdrawn from the feed tank D. If the demand in the boiler-house is less than the amount of water delivered into the feed tank D by the extraction pump the excess water will flow down the overflow pipe from the tank Z and thence back to the auxiliary tank H, from which it is drawn into the main condenser as before. This also has the effect of raising the water level in the suction pipe connected to the extraction pump B and of closing the float valve operating in the tank L, thus diminishing the by-pass water from the feed tank D to the surface condenser. Thus any water make-up, or otherwise, fed into the boilers under varying loads is de-aerated and is kept out of contact with the atmosphere.

When the auxiliaries of a power station are driven by small steam turbines a very fair amount of steam is required for their operation, and if this amount of steam is more than can be condensed by the feed water a loss of heat occurs, and the feed pumps may have difficulty in dealing with the water on account of its high temperature. The steam and exhaust connections may also involve the use of a considerable amount of piping and valves. When, on the other hand, electrically driven auxiliaries are used and are driven from the main machine, there is always a possibility of a complete shut down. The ideal arrangement is an auxiliary or house turbine, but if this set is arranged to run condensing with ordinary circulating water there is a considerable waste of heat because the latent heat or heat of evaporation in the exhaust steam is lost in the circulating water.

In the Hick, Hargreaves closed-feed system this loss is obviated by passing the condensate from the main machines through the house turbine condenser, and the heat of evaporation in the steam condensed in the latter is thus added to the feed water on its way to the boiler feed pumps. This, the makers explain, gives maximum thermal efficiency, and is more efficient than the practice of bleeding the main turbines, because in the latter case the steam does not have the same amount of heat energy extracted from it. In other words, the steam bled from the main turbines does less work per pound than that exhausted by the house turbine before being used for heating purposes. When the question of partial load is considered it is found that whereas the amount of condensate from the main sets decreases approximately in proportion to the load, the auxiliary load is a constant load, plus a load in proportion to the number of main sets

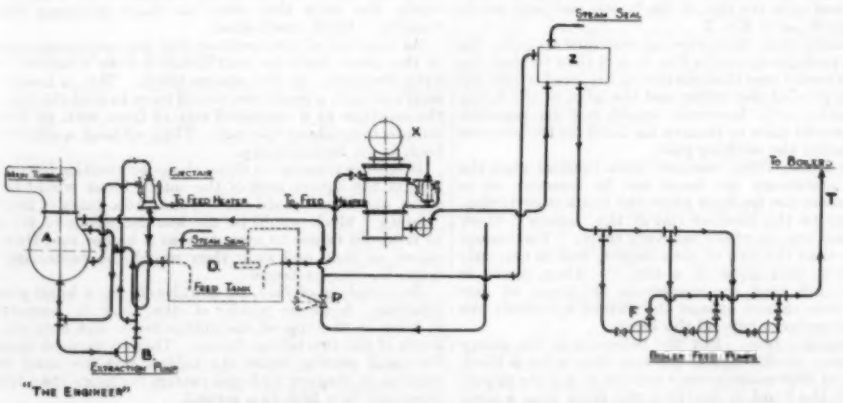


FIG. 4—CLOSED FEED SYSTEM WITH A JET CONDENSER

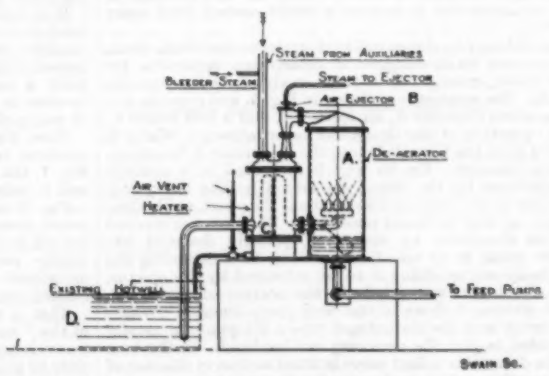
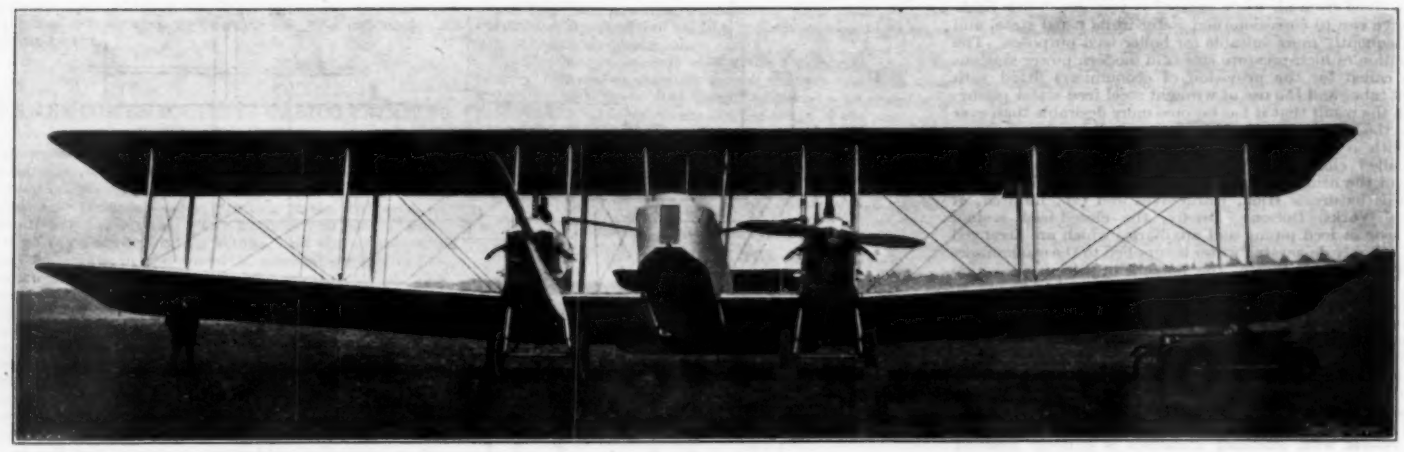


FIG. 5—DE-AERATING APPARATUS

THE VICKERS VIRGINIA TWIN-ENGINED BIPLANE

VICKERS LIMITED, WEYBRIDGE, ENGINEERS



running. Hence at certain loads the amount of water available for condensing the auxiliary steam from the auxiliary set is insufficient, thus causing the vacuum in the house turbine to be reduced or entirely lost.

In the case of the Hick, Hargreaves closed-feed system, an ample circulation of water through the house turbine condenser is assured. The supply is quite independent of the amount of condensate coming from the main unit, so that the house turbine can operate under maximum load, irrespective of what the demands in the boiler-house may be or what load is being carried by the main machine.

This, the makers contend, is a very great advantage, and which applies equally well when a feed-water heater is used to take the exhaust from steam-driven auxiliaries which are distributed about the station.

In Fig. 2 the closed-feed system is shown working in conjunction with a house turbine and its condenser, which acts as a feed-water heater. In this diagram it will be noticed an evaporator G has been included for giving a supply of distilled water for make-up purposes, an evaporator of this sort being found necessary in the majority of cases. The operation of the system corresponds to that of the scheme shown in Fig. 1, but the make-up supply is obtained from the evaporator G, the vapour from which being carried into the house turbine condenser, where it is condensed by the feed water on its way to the boilers, the condensate being led to the auxiliary tank H as before. In this case the float in the main feed tank D controls the steam supply to the coils of the evaporator, thus varying the duty of the latter in accordance with the rise and fall of level in the feed tank, so that the level in the tank is maintained.

In all the diagrams the same letters refer to the same parts, which are as follows:—A, main condenser; B, extraction pump; C, surface feed heater; D, closed feed tank; E, lift pump; F, boiler feed pump; G, evaporator; H, auxiliary tank; L, float chamber; M, "ejectair;" N, Venturi meter; O, Venturi meter; P, make-up; R, steam connection to evaporator coils; S, exhaust from auxiliaries; T, feed pump discharge to boilers; X, feed heater or house turbine condenser; Z, closed tank.

The Venturi meter O shown on the discharge of the extraction pump B measures the gross amount of water discharged by this pump. Another Venturi meter N is used for measuring the amount of water by-passed from the auxiliary tank H and also the float tank L. The quantity of water registered by the Venturi meter O is always greater than that registered by the meter N, and the difference in these two readings gives the amount of steam condensed from the main unit and enables the steam per kilowatt to be ascertained without difficulty.

The drawing—Fig. 3—shows the Hick, Hargreaves closed-feed system applied to three main turbine units, and it will be seen that the same characteristics are embodied in this scheme as in the others. In Fig. 4 the surface condenser attached to the house turbine is replaced by a condenser of the jet type, the condenser drawing its supply of injection water from the feed tank in the usual manner, and the extraction pump attached to the jet condenser then takes the place of the lift pump E. The function of the jet condenser is that of a direct-contact feed-water heater.

In addition to the closed-feed systems described, Hick, Hargreaves have designed a de-aerating apparatus for feed water, arranged so as to be easily applied to existing plants. The apparatus is shown in Fig. 5, and consists of a de-aerating chamber A, air ejector B, and a feed heater C. The operation of the de-aerator is as follows:—Water is forced from the hotwell D into the de-aerator A by atmospheric pressure. On its way it is heated to a suitable temperature by the steam discharged by the air ejector and also steam from auxiliaries about the plant, or bleeding steam, as may be found necessary. The water is sprayed in the de-aerator by means of specially designed jets which break it up into fine particles, thus liberating the air freely and enabling it to be extracted by the ejector. The de-aerated water falls to the bottom of the vessel, from whence it flows to the feed pump suction. Where the latter is of the centrifugal type a lift pump is usually provided to give the necessary suction head. In the base of the de-aerator a float valve is fitted so that in the case of a heavy demand for feed water the float will fall, admitting more water into the de-aerator, the reverse action taking place should the feed water required be curtailed. The air extracted by the ejector from the de-aerating chamber is finally discharged to the atmosphere by the air vent shown, and at the same time the drips from the heating coils are collected in the hotwell. As will be gathered from the illustration, the arrangement is very compact and is made up of parts which are not liable to get out of order.

Briefly summarised, the advantages claimed for the Hick, Hargreaves closed-feed system are:—(1) De-aeration of all water fed into the boilers; (2) no attention is required; (3) the plant works entirely automatically without the use of any special automatic apparatus, pressure-regulated valves being dispensed with; (4) the amount of make-up is automatically regulated to suit the demands of the boiler; (5) standard apparatus can be used throughout; (6) the feed tank is at such a temperature that the heat lost by radiation, evaporation, &c., is negligible; (7) the feed heaters are only at atmospheric pressure and can therefore be of light construction; and (8) the system can be applied to existing stations without undue complication.

Vickers "Virginia" Biplane.

WE illustrate above the latest product of Vickers' aircraft establishment at Weybridge, namely, the Vickers "Virginia" twin-engined biplane. As the machine has been built for the Air Ministry for military purposes, detailed information regarding its design and construction cannot be published. The engines are Napier "Lions" of 450 horse-power each, and, as shown in the engraving, are mounted on the central section, the wings on either side folding backwards to reduce storage space. The precise duty for which the machine has been designed is not stated, but it seems evident from the details visible in the original photograph that it belongs to the bombing class.

The Fallacy of the "Safety" Cutter Block.

IT is difficult to say who first took it into his head to describe the circular cutter block used on rotary wood-planing machines as a "safety" cutter block. Certain it is that the whole of the trade has accepted the phrase, and equally certain is it that the Home Office has taken this catchword "safety" in all seriousness and made it a legal offence, in its recent regulations for safety in sawmills, for any other class of block to be used on hand-feed planing machines.

And yet the "safety" block has no more to do with safety than has the average "Ostend" rabbit of the *menu* to do with Ostend.

The fallacy has arisen from the undeniable fact that when a cutter-spindle is stationary and a square block is used, it is possible to place a considerable portion of the hand below the level of the table and well inside the cutter track, as shown by Fig. 1, whereas with a circular block the rim of the block nearly fills up the gap between the tables, and only the tips of the fingers can pass inside the cutter track, as in Fig. 2.

It is certainly true that were an operator to place his hand in the position shown in Fig. 1, and then to start his machine, he would lose that portion of his hand which lies between the edge of the cutter and the edge of the table. Such a contingency, however, would not be possible, because he would have to remove his hand for the purpose of manipulating the striking gear.

Now, the Home Office assumes that because when the machine is stationary the hand can be inserted, as in Fig. 1, the same can be done when the block is revolving, and it points to the circular rim of the "safety" block—Fig. 2—and says in effect and very truly, "You cannot insert more than the tips of your fingers, and so can only cut off a very thin slice at a time." Then, again, it rightly contends that the maximum thickness of any individual slice cannot exceed the extent by which the cutting edge projects beyond the block.

That is equally true. But the believers in the safety of the "Safety block" ignore the fact that when a block is revolving at 4000 revolutions a minute, it is quite impossible to push the hand or anything else more than a mere fraction of an inch inside the cutter track, because anything that impinges on that track is instantaneously removed by being cut off whether a square or a circular or any other form of cutter block is used.

Let us assume that a "safety" block is running at 4000 revolutions a minute and is carrying two cutters only, and that the cutters project only an eighth of an inch beyond the surface of the block. Such a block cannot cut an individual slice of more than an eighth of an inch, but it can cut 133 such slices in a second. In other words, it is capable of cutting off not only the tips of the fingers but the whole of the arm up to the elbow in one second.

How nearly it approaches to this maximum of capacity for damage depends in no way on the shape of the block, but (1) on the direction in which the hand is presented to the cutter; (2) on the impetus and momentum which are behind that action; and (3) on the size of the gap between the tables.

With a "safety" block on a hand-feed planer three cutters are often used. This increases its mutilating capacity from 16in. to 24in. per second, whereas the square block on such machines never carries more than two.

Now let us consider the potentialities of the square block for mutilation. At the same speed and with the same number of cutters those potentialities are quite as great as those of the "safety" block, but no greater.

This is because although there is no "protecting" circular rim within a fraction of an inch of the cutting edges, the knives follow each other so rapidly that it would be impossible for the fingers to touch such a rim if it were there.

The writer has witnessed many accidents on the square

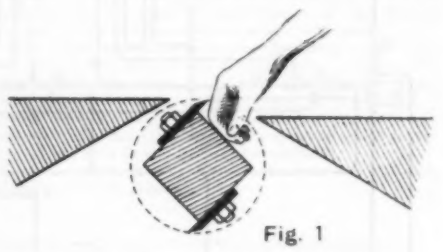


Fig. 1

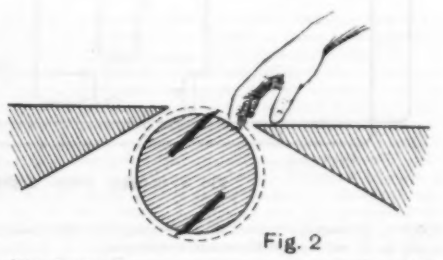


Fig. 2

"THE ENGINEER" SWAIN SC.

block machine, and in every case where the severed portions could be recovered, they have all been in precisely the same thin slices as those resulting from a "safety" block mutilation.

As a matter of fact, nothing like the maximum capacity of the block itself for mutilation is ever attained either with the safety or the square block. This is because to arrive at such a result one would have to feed the arm into the machine at a sustained rate of from 80ft. to 120ft. a minute throughout the cut. This, without a mechanical feed, is an impossibility.

If it were possible to do so the potentialities for mutilation of the square and of the safety block would be the same, and if one could get beyond those rates of feed the "safety" block would be the less dangerous of the two, as it would refuse to amputate at a higher rate than the above, as then and only then would the protecting rim begin to offer protection.

As a matter of fact, all mutilation on a hand-planing machine, however much of the limb is amputated, is done on the top of the cutter track and between the levels of the two tables shown. There is no such thing as the hand getting below the tables, and the hand never remains in contact with the cutters for more than from a twentieth to a fifth of a second.

The removal of the hand from the cutter track is never due to any voluntary action of the operator, for it is all done before he realises that it has happened. This is because the action of the cutters is to repel violently anything which comes in contact with them and the severity of the mutilation, before such repelling action takes effect, depends upon the impetus behind the action which effects the contact.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Pig Iron Situation and Coke Supplies.

THE strength of the pig iron market has been emphasised during the past week, further additions having taken place to selling values. Northamptonshire foundry iron is now quoted up to £4 10s., and Derbyshire up to £4 12s. 6d. These figures show a price increase of about 10s. per ton within the past fortnight. The general run of business this week has, however, been done at about half-a-crown below these quotations. The demand for pig iron is stimulating business even in Staffordshire, which has all along lagged in the rear of other districts. While in a few cases material held by merchants is on offer at prices appreciably below replacement cost, quotations at the other end of the scale are still more misleading, since they are not intended as negotiating figures but merely mean that producers who name them are off the market. Prompt iron is practically unobtainable, for there are no stocks at furnaces. With practically the whole of their output for the first quarter of the year booked up, Midland makers are unwilling to accept additional contracts. Smelters who a few months ago were bemoaning the refusal of customers to buy forward are now afraid to bargain for future deliveries owing to the uncertainty of production costs, and of the facilities for maintaining output. Those in the best position to judge, frankly declare that the outlook fully justifies the rekindling of their furnaces. The production of several other furnaces could now be utilised without any difficulty, and the advance in price would make the manufacture of pig iron a sounder proposition than at any time since the coal strike. Some makers would gladly make active preparations to this end, but they are faced with the difficulty of securing the necessary supplies of fuel. The coke position is regarded with much uneasiness. Big sales have been made to the Continent as far forward as April at very satisfactory prices. This has greatly restricted the amount of fuel available for home consumption. The attitude of the coke suppliers has thoroughly unsettled confidence. Higher prices for coke are talked of, but price is no longer the dominant factor, however; the essential fact is that the supply is insufficient. Owners of idle furnaces who have not made contracts are hopeless as to the ability to obtain the necessary fuel for a restart. Several of the operating furnaces, including those belonging to large concerns, are stated to be running on slack blast for lack of coke. One reason assigned for the shortage of coke is the disrepair into which many of the ovens have been allowed to fall. This defect is being removed very gradually. But apart from a coking plant which is being restarted in Derbyshire, it does not appear that very much is being done in the Midlands. There are plenty of idle coke ovens which could be started if abundant fuel at the proper price were obtainable, but the small material from which coke is made is scarce, and dear, and the business accordingly does not expand. It is very hard on blast-furnace owners, and it will be very hard on many other industrialists if the new trade movement which is coming into sight is to be frustrated by a shortage of raw material. It will be doubly hard if a shortage is brought about as a consequence of handing over to competitors abroad a considerable share of our means of production.

Brisk Business in Steel.

Business has been very brisk in the semi-finished steel department, and producers are taking a firm attitude. They have made the minimum for billets £8, and it is difficult to find sellers willing to accept less than £8 5s. Mills which have full order books are now quoting £8 10s., but this figure is not indicative of actual business except in special circumstances. Continental supplies have entirely failed. It is understood that the political situation is largely accountable for the inability of French and Belgian steel works to undertake contracts. Many consumers of steel in this district would be glad to take advantage of foreign semi-finished material if it were available. Finished steel is also dearer. Angles for structural work have again been advanced 5s. per ton, making the quotation of Staffordshire mills £9 15s. Joists have been put on the same level, while small bars now stand at a minimum of £9 15s. Staffordshire hoops are based on £11 10s. at works, which is sufficiently low to keep out the Lancashire products, the latter having undergone a sharp advance.

Dearer Nut and Bolt Iron.

Finished iron prices are being driven up by increasing cost of pig iron, scrap, and fuel, so that mill-owners say they are worse off to-day than two months ago. However this may be, there is deep misgiving lest the upward movement should overstrain the complaisance of consumers. Lancashire houses competing in this district have put up their prices for nut and bolt bars to £10 15s. per ton. Staffordshire makers move at a less rapid pace, but as for the time being they are freed from Belgian competition, the political situation abroad preventing inquiries being entertained by continental exporters, they will no doubt gradually come into line. Meanwhile the Staffordshire-made bars for the nut and bolt trade can be obtained at 5s. less than the Lancashire quotation. The local figure of £10 10s. is, however, an advance of 5s. on last week's price. It is doubtful if a good order would be rejected at £10 7s. 6d. No departure has been made from the £13 10s. basis for marked bars, and for good qualities of second-class bars the quotation is round about £11 up to £11 10s. The sheet trade continues very healthy, and galvanised sheet prices have improved on the week. No quotations under £18 10s. are now heard of for 24-gauge corrugateds, and £18 15s. is fairly common, particularly where the specification is not regarded as favourable. The black sheet trade is fairly busy to meet demands of the motor industry among others.

Ironworkers' Wages Reduced.

Under the sliding scale of the Midland Iron and Steel Wages Board ironworkers' wages have this week undergone a reduction of 2½ per cent. This is the result of the November-December ascertainment, which revealed a drop in the average net selling price of a little less than 2s. per ton. Under the previous ascertainment wages were advanced by 2½ per cent. The latest movement was not unexpected in view of the keen price cutting which has been a prominent feature of the Staffordshire iron trade for some time. The present fall in wages has been brought about principally by the check in the upward trend of lower class bars during December. The balance will, in all probability, be restored in the next ascertainment in an accentuated degree, for prices have firmed up considerably of late, and Staffordshire nut and bolt bars, which were selling at £9 15s. at the beginning of the year, are now commanding £10 7s. 6d. to £10 10s., while Lancashire makers quote £10 15s. More cheerful developments are, therefore, anticipated.

Midland Trade Conditions.

The recovery of the Midland industries progresses steadily. The fact that orders in hand warrant the working of overtime indicates that the trade outlook is far healthier than it has been during the past year. Constructional engineers report a record flow of new business, but there is some hesitation in tendering owing to the increased prices of raw material. Nevertheless, pending contracts continue to materialise. Some departments of mechanical engineering in the Midlands are showing greater activity. Builders of special engines, particularly in connection with electricity generating plants, have good orders going through. These and a few exceptionally circumstanced motor car firms are running night shifts. Electrical engineers and some of their coadjutors have had many opportunities of strengthening their order books since the year opened. In these branches, where so large a part of production costs is represented by skilled labour, the appreciation of raw material has had little or no effect on demand. Some firms say it has stimulated buying. Midland firms continue to benefit from contracts placed by the various Government departments; the latest include orders for bridge steel work, stampings, galvanised water pipes and fittings, railway stores, petrol engine spares, radiators, and padlocks.

Rolling Stock Business.

In the heavy engineering industries of this district there is a definite improvement. The rolling stock works are fairly well employed, for while the reorganisation of the home railways has not as yet produced orders of any magnitude, foreign and colonial railways are replacing stores. The principal rolling stock concerns are convinced that the placing of substantial contracts cannot be long delayed. The export demand, on which the great wagon-building concerns in this district depend more especially for steady employment, is not developing as rapidly as could be wished, though there is a movement in the right direction in South America. More contracts will probably be forthcoming from India, as those in hand are worked off, but managements can only secure regular running for their plants by quoting keen prices, and there is still a big surplus of productive capacity. Wagon builders still have to reckon with keen competition from Belgium in the export markets.

Steel Pipe Contract for Birmingham.

I learn that the Cardiff Waterworks Committee has accepted the tender of Messrs. Piggott, of Birmingham, for half the steel water mains for a second pipe line from Taff Fawr to Cardiff, at £118,222. All the steel plates required, it is understood, are to be made in Cardiff.

Miners' Strike at Halesowen.

A considerable number of miners employed at the Golden Orchard Colliery, Halesowen, belonging to the Coombs Wood Colliery Company, struck work on Saturday last in consequence of the introduction at the pit of tonnage rates in place of day rates. The men contend that under the changed system an appreciable number are unable to earn sufficient wages.

Still Fewer Workless.

There is a still further decrease in the number of unemployed registered at the Labour Exchanges in the West Midlands area. On January 15th the number was 169,724, and for the week ended January 22nd it was 165,709. The latest returns for the week ended January 22nd show the reduced total of 161,260. The larger number of unemployed are in the following towns:—Birmingham, 54,104; Coventry, 5536; Cradley Heath, 6729; Dudley, 5255; Smethwick, 6865; Walsall, 7241, Wolverhampton, 10,018.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Conditions.

THE general improvement which has been reported lately in the iron and metal trades continues so far as iron and steel are concerned, but seems to have received a check in the non-ferrous metal market. Of course, this may be only temporary, and one is inclined to be a little doubtful as to the permanency of the improvement in iron and steel. The causes of it are too clearly connected with the disorganisation of the trade on the Continent to be at all satisfactory, for the sane man of business does not believe that the trade of one country can be improved by the destruction of the trade of another country. The rather rapid rise in some of our prices is also a movement which may be followed by a restriction of trade, for one doubts whether industry is yet in a condition to justify any increase in the costs of manufacture.

Copper.

The market for copper has been supported lately by very optimistic reports from America, but it is now a question whether this kind of thing has not been overdone. A big "bull" account has been built up in copper, as in some of the other metals, and the recent prophecies of higher prices from America may be an attempt to ease the liquidation of this account. The disturbed state of European politics is a factor which cannot be ignored, and if the industries of Germany are to be starved out by the shutting off of fuel supplies this may have a very depressing effect on the copper market. No doubt the consumption in America is fairly good, and even here there are signs of improvement, but one may doubt whether the total increase in consumption does more than balance the growth in production. If copper prices are to recede again it seems a pity that manufacturers should have increased the official prices in the manufactured section of the trade. Considering the enormous gap between raw copper and some of the "manufactured" prices, there could be no necessity to take notice of the rise of £2 per ton in Chili bars or refined ingots. Nevertheless, the price list has been altered; strong sheet copper has been advanced to £98 per ton, and flat copper bottoms to £108; solid drawn copper tubes are put up to 1s. 1½d. per pound, and solid drawn brass tubes to 1s. The price of 4ft. by 4ft. copper "braziers" for India, which was £13 below the price of strong copper sheets, is raised by only 10s. per ton to £83 10s. This circumstance alone is indicative of a state of things which enables the manufacturer of copper and brass to do with the consumer in this country just what he likes. The market for tin has receded to a certain extent, and this is attributed to the bad political news. The statistics for the end of January, although showing a slight increase upon the stocks in Great Britain as compared with the end of December, are not thought to have had any effect on the market. The markets for lead and spelter remain fairly strong, although prices have been a little lower. The big advance in lead which has recently taken place was likely to lead to some reaction, but apparently the view taken in the market is still favourable. America is very strong, and the prices there will continue to attract supplies, so that it is improbable that the supply here will be increased to any extent. Spelter is in a fairly good position, and the demand for galvanising purposes is better on the further advance in the price of galvanised sheets.

Pig Iron.

The market here for foundry iron is again very firm, and there is a further tendency to advance. Prices for Derbyshire iron seem to be rather irregular, some makers trying for as much as 95s. at the furnaces, which would mean 103s. 6d. or more in Manchester; but No. 3 Derbyshire pig can still be bought for delivery over this month in Manchester at 100s. per ton, and perhaps in some cases at a little less. There is not so much business being done now, as a great many ironfounders refuse to follow these prices for the present. Makers, on the other hand, point to Cleveland and Scotch prices and to the cost of fuel, and are of opinion that their prices are quite moderate in the circumstances. There has been a further advance in the prices asked for East Coast hematite, owing, apparently, to the sharp shipping demand from the Continent. The cost of hematite now in Manchester would be nearly £6 per ton. Hence those ironfounders who have been buying it to use instead of Scotch iron may just as well go back to their old custom. There is, however, not much demand here now for Scotch iron, and many founders say that they cannot afford to pay the price for it.

Finished Material.

There has been rather a better demand for finished iron and steel here, and in other centres of the trade a considerable increase in business is reported. Here the prices were advanced early, but in other places this was not the case. Latterly, however, prices have been moving and in Scotland an advance of 20s. per ton has been made in steel sections, bringing the Scottish prices on about a level with the Midland prices.

Scrap.

The market for scrap iron and steel is firmer, and there now seems to be a scarcity both of steel and of heavy wrought scrap iron. The Lancashire price for heavy melting steel scrap is now up to about 80s. per ton on trucks, although the Sheffield consumers are struggling against this advance. For heavy wrought scrap some of the ironworks will now pay £4, although it is not so long ago that they were refusing it at £3 5s. Cast scrap is getting better under the influence of pig iron, but it is still a comparatively cheap material.

Proposed Manchester and Liverpool Road.

The Parliamentary Sub-committee of the Manchester Corporation, at a meeting held on Monday last, considered the new road scheme between Manchester and Liverpool, and passed a resolution unfavourable to the construction of the road.

The Engineers' Club.

A house dinner to commemorate the completion of the first section of the extensions of the Engineers Club, Manchester, was held on Friday last, and was very numerously attended. The President, Mr. J. S. Webb, and Mr. Bertram Thomas, the chairman of Committee, in reply to the toast of the Club, appealed to those present to assist in securing an increased membership. The recently added accommodation will enable the Committee to extend the membership considerably, and it is hoped that towards the end of the present year the position in this respect will be still further improved. By that time it is anticipated that the smoking room and other departments will have been extended, and the congestion relieved. It is the earnest desire of the Committee to

make the Club the centre of all the engineering activities in the district, a meeting place for the several technical societies, and a place for the recreation of its members. The membership is now over 800, and of this number more than 700 are town members.

BARROW-IN-FURNESS, Thursday.

Hematite.

The hematite pig iron trade is in a very healthy condition, and there is no lack of inquiries and orders. Since last week there has been little change beyond a stiffening in trade and further increases in price. The various orders which are being placed in this country with shipbuilders and engineers are bound to affect the pig iron trade, and there is little doubt but that the trade generally will go on improving. There are no more furnaces in blast yet, but it will not be long before some of the makers are compelled to increase their output. The trade with the Continent continues to be satisfactory, but it is the British customer who is responsible for the improvement. The Scotch business is growing, as also is trade with the Midlands.

Iron Ore.

The local iron ore trade steadily improves, and some of the mines are experiencing better business than they have for some time. There is every reason to expect that this trade will develop more as time goes on. As regards foreign ore, there is a regular consumption, but there have not been heavy imports in view of the stocks which have accumulated at the docks. These are being reduced gradually.

Steel.

There is a little better outlook in the steel trade. The Workington rail mill will start again on the 19th with orders sufficient to take it on for a few weeks. In the meantime there may be more orders booked. The Barrow rail mill is engaged, and will be till after Easter, with orders already held. The hoop and small bar mills at Barrow are also engaged. Foundries are experiencing a little better trade.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Activity.

THE heavy departments of the Sheffield steel trade continue to be well employed, and conditions generally show some improvement. The reduction of the number of unemployed in the city is a slow matter, but it is gradually coming about. For the first time for a long period, the number out of work has now dropped below 35,000, the actual figure last reported being 34,979, a decrease of 345 on the week. There is quite a scarcity of basic steel, despite the large output, and further production is needed. The same condition obtains in pig iron, and it is essential that more blast-furnaces should be put into operation. The difficulty in this case, however, is a shortage of coke, as not enough small fuel for making it is being got out of the pits. Efforts are being made to tackle this problem. The Staveley Coal and Iron Company, for example, is now turning out 5000 tons of pig iron per week, but Mr. C. P. Markham, the chairman, states that that is not enough. The company needs 1000 tons of slack per day for coking, and it is its intention to deepen Warsop Main Colliery with a view to increasing its supplies of coking coal. There has been an increase in the price of pig iron since last week. There is also a hardening in coal prices, and some collieries are asking for an advance of 2s. all round, while others are demanding a shilling.

Effect of Ruhr Occupation.

The chaotic conditions in Germany have had a beneficial effect on the heavy steel trade. There has lately been a considerable increase in business in pig iron, steel billets, and certain classes of rolled steel, and a great many inquiries are afoot. This improvement is no doubt due, to some extent, to uncertainty as to the ability of Germany to give deliveries. While some foreign users, who have been in the habit of buying German material, are holding back their orders in the hope that stability may be restored, others, whose needs are more immediate, are putting their business through in this country. The prolongation of the difficulties in the Ruhr will, it is natural to expect, impair Germany's power to compete with us, and will be all to the good of the home trade, both locally and farther afield.

The Lighter Trades.

A little improvement is noticeable in the departments producing tool and special steels, and tools made from them; but the increased business is on a restricted scale, and very unevenly distributed, some makers reporting that they are as poorly placed for work as ever. Certain branches of engineering are experiencing a revival, which is resulting in an improved demand for best tool steel, twist drills and similar tools, and also files. There is still a very poor colonial and foreign demand for files, in which American competition is very acute. Satisfactory orders are coming in for garden tools, and a fair opening is reported in the season for farm tools. The demand from agricultural implement makers for steel parts and knives is, however, below the average. Trade with Russia is practically at a standstill at present.

Cutlery and Plate.

There is nothing very fresh to say about the state of the cutlery trade, the only satisfactory feature of which is the activity of the stainless steel table knife department, and even there some firms are not at all well placed for work. The Colonies are sending forward a moderate amount of business, but the volume is not up to the average of normal times. In pen and pocket cutlery, and razors trade is very quiet. In electro-plate and silver ware, trade keeps up fairly well. The returns for January are better than were anticipated, and show up very well in comparison with twelve months ago. Useful orders for spoons and forks continue to come in from several markets.

An Important Road Scheme.

New schemes of public utility continue to come forward, and the past week has seen an exceptionally large crop of them. One of the most interesting, locally, is a Sheffield proposal for the construction of a new trunk road to connect the city with Leeds, 32 miles away. Severity of gradients, awkward twists, and narrow stretches, have made people dissatisfied with the existing routes for a long time, and it is felt that the present would be a favourable moment for putting the project in hand, as it would provide much needed work for the unemployed. The Sheffield Corporation is in favour of it, and both the Lord Mayor and the chairman of the Finance Committee spoke about it at last week's meeting of the Council of the Chamber of Commerce. Already the ground is being looked over with a view to finding some easier way of connecting the two largest cities in Yorkshire. The cost of the scheme is estimated at £700,000 to £1,000,000, and the Ministry of Transport would bear half of it. The scheme has the warm support of motorists and other road users. If carried out, it would involve the co-operation of the various local authorities *en route*, and it remains to be seen what the Councils of Leeds, Barnsley, Wakefield, and the West Riding will have to say to it.

Colliery Developments.

Considerable advances have been made with the sinking of the Harworth pit, the two shafts of which are now down 550 yards, or more than half the distance at which it is expected that the Barnsley seam will be reached. There is some hope of winning coal by the end of this year. The concrete foundations for the screens and coal washer have been put in, the power and winding houses are nearing completion, the permanent offices are almost ready for occupation, and the new railway line from the colliery to the old Great Northern Railway main line at Scrooby is almost completed as far as the Blyth-road.

Light Railways in South Yorkshire.

A very important scheme for linking up certain small towns and villages in the Barnsley district has now been definitely inaugurated. The Dearne District Light Railways Joint Committee, which represents the Urban District Councils of Wombwell, Wath, Bolton, and Thurnscoe, has accepted the tender of the Consolidated Construction Company, Limited, for the construction of about fifteen miles of light railway. The price is £200,243, which, it is understood, covers the cost of rolling stock as well as of construction. The railway will be laid along existing roads for the greater part of its length. There has been some opposition to the scheme on the part of people who have doubts as to its financial success, but the promoters believe it to be a sound undertaking, which will develop the trade of the district. The clerk of the Wombwell Urban District Council has expressed the opinion that trams will be running through the district in about eighteen months. Mr. Arthur R. Hoare, of Messrs. Stephen Sillons and Partners, tramway engineers, of Westminster, is the engineer for the scheme.

East Yorkshire Projects.

The great projects in the East Riding, to which I have previously called attention, continue to be pushed forward. Since I last wrote, a conference of East Riding authorities, under the auspices of the Ministry of Transport, has decided in favour of the construction of a bridge across the Ouse at Boothferry, at a cost of £100,000. The Humber Tunnel scheme has been placed before the Ministry of Transport by a deputation of commercial men, who waited upon Sir William Marwood. The proposal put forward was for a tunnel from a point near North Ferriby, west of Hull, to the Roman road on the Lincolnshire side of the river. The whole construction would be four miles in length, and the actual length of the tunnel about 2½ miles. It is suggested the tunnel should be about 30ft. in diameter. It would be a similar type of tunnel to that proposed under the Thames at Rotherhithe, the idea being to take mainly passenger and goods train traffic, and not much foot traffic. A sum of £2,000,000 was suggested as the probable cost. Sir William Marwood, in reply to the deputation, said if the completed scheme was produced on paper, and it was shown that the County Councils of the East Riding and Lincolnshire would find their share, then would be the time when the Government would be prepared to go further into the matter. The question of a railway tunnel was not one for the Ministry, but must be discussed with the railway companies. The County Councils should be approached with regard to the roads, as someone would have to take responsibility for their maintenance when made. The suggestion has now been put forward that the tunnelling scheme might be carried out in conjunction with the land reclamation project, to which I have previously referred. The great difficulty with regard to the latter is that of obtaining material for the foreshore, and the idea is that the material taken out of the tunnel could be utilised for this purpose. The Hull and Grimsby Chambers of Commerce have passed resolutions in favour of the tunnel scheme.

NORTH OF ENGLAND.

(From our own Correspondent.)

Active Trade Conditions.

THE trade position in the North of England is looking better all round, and a period of greater industrial activity appears to lie ahead. Not very long ago work was very difficult, indeed almost impossible, to secure. Now there is a crescendo of activity, especially so in the iron and steel trades. In the pig iron trade the demand is considerably in excess of the supply, and many consumers find themselves in a difficult position, being unable to cover their requirements. They, however, have only themselves to blame. For some time consumption has been increasing at a much more rapid rate than production, and it was apparent that the output was likely to fall short of the requirements of the trade. No doubt it has been expected that more furnaces would be put into blast as the needs of the trade increased, and in normal circumstances this no doubt would have been the course adopted by ironmasters, who are eager enough to see their idle plant in operation again. But the circumstances are quite abnormal. The French occupation of the Ruhr has led to such a shortage of fuel on the Continent that consumers abroad have been prepared to pay almost any price for supplies. Sales to the Continent of British coal and coke have reached an enormous total, and whilst this may be good for the coalowner, it is bad business for other British industries. It has made fuel both dear and scarce, and although local ironmasters are getting their coke at a preferential rate far below the export value, coke makers naturally want some of the cream, and prefer to sell any surplus abroad rather than to supply increased quantities to local ironmasters at a lower price. Hence the delay in increasing the production of pig iron. With a plentiful supply of cheaper fuel there is no doubt that many additional furnaces would be put into operation, but of that movement there is no immediate prospect.

Iron and Steel Exports.

The January exports of pig iron, manufactured iron and steel from the Cleveland district totalled 80,607 tons, the smallest since August last. The decline, however, is only slight as compared with the December total, when 89,329 tons were shipped. Including the Skinningrove shipments, pig iron exports totalled 41,308 tons as against 44,416 tons in December, and of the former total 14,767 tons went coastwise and 26,541 tons abroad. As a result of the gradual exhaustion of the contracts for delivery of Cleveland pig iron to the United States, the shipments to American ports fell from 22,450 tons in December to 5342 tons in January. Scotland received 8994 tons, Italy 7500 tons, Belgium 3377 tons, Wales 3464 tons, Denmark 2802 tons, and Germany 2185 tons. The manufactured iron and steel shipments were approximately 5000 tons down on the month, but December was an exceptional month, and a total of 39,299 tons is about 1800 tons above the average for each month of last year. India and Ceylon took 12,762 tons, or over 5000 tons more than in December; but 10,326 tons shipped to Australia and New Zealand represented a fall of exactly 4000 tons.

Cleveland Iron Trade.

The situation in the Cleveland pig iron trade shows little change. Business is entirely governed by the extent of the available supplies, and as these are very meagre, transactions are limited to the exchange of small parcels, although there is an active forward business for deliveries up to the end of April. There is a strong demand for iron from all quarters, and as at some producers' works practically all the iron is required for the firm's own steel furnaces, there is really a smaller quantity left to meet the needs of other buyers. Generally, makers of foundry iron are sold out for February delivery, but an occasional odd lot comes on to the market, and prices ranging up to 112s. 6d. have been paid for these lots. The market price, however, may still be put at 105s. per ton for No. 3 Cleveland pig iron, that, of course, being for March-April delivery. No. 1 foundry iron is quite nominal at 110s. per ton for forward delivery, No. 4 foundry readily realises 100s., and No. 4 forge is quoted at 95s.

Hematite Pig Iron.

There has been a big rush for East Coast hematite pig iron, and many makers cannot book further orders till March. Heavy sales have been made to Italy, where consumers can no longer get the cheap German iron on which they have hitherto relied. Home steel makers have also bought freely. Two more blast-furnaces are being started at the Redcar ironworks, but the output will be needed in the local steel works, and possibly none will come on to the market. The price of mixed numbers is now put at 105s., though possibly that figure would be cut for forward business.

Iron-making Materials.

Business in foreign ore is still on a limited scale, but it is thought that buyers cannot hold off much longer, and there is no weakening in prices. Best Rubio ore ranges in price from 24s. to 24s. 6d. per ton c.i.f. Tees. Coke prices are extremely irregular. For good medium furnace coke 35s. per ton has been paid, but such a price is not in the best interest of either the coke trade itself or the iron trade, with the prosperity of which it is indissolubly linked. Recognising this, some of the principal firms are renewing contracts with the ironmasters at about 33s. per ton delivered at the works.

Manufactured Iron and Steel.

Greater activity is reported in the manufactured iron and steel trade, and the demand continues to expand. Export orders are more numerous, but it is the fulfilment of the needs of the home trade which is keeping the works going. Prices show a marked upward tendency, and a definite advance seems inevitable having regard to the rise in fuel, pig iron and scrap.

The Coal Trade.

The Northern coal market now presents a remarkably quiet appearance in contrast to the situation a fortnight ago. All the fever has subsided for the moment, and, as a rule, business proceeds along more normal lines. The position, generally, remains very steady and assured in all instances. The rush for supplies, however, and the apparent recklessness in conceding any price demanded have disappeared, and the usual atmosphere of bargaining now prevails. There is reported to be a persistent and

very heavy call for all kinds of fuel for Germany up to well past the middle of the year. So far as can be judged, the demand is likely to continue for some time to come, especially in view of the French action in prohibiting the dispatch of coal to unoccupied Germany from the Ruhr Valley, so that a steady trade in that quarter for awhile may be expected to continue. From other European countries, however, the demand is not quite so pressing, which is probably to be accounted for by the sudden advance in prices. Steam coals are a shade easier, with about 28s. for best brands as approximately a maximum, and in some cases this figure can be shaded. Durham gas coals of every kind are well upheld, the strongest features being coking coals of all kinds and special and prime brands of gas and bunkers. Foundry and furnace coke is still very scarce and strong, while gas coke is fairly steady in demand at current figures.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THE conditions governing the South Wales steam coal trade have not undergone much, if any, change since I wrote a week ago. Shipments continue on a fairly active scale, although the total amount for last week was rather less than for the previous week; but this was accounted for by the fact that the weather and working conditions at the docks were very unsatisfactory, and caused a slackening of operations. The general demand for coals remains about the same, although the political conditions on the Continent still exercise a somewhat disturbing influence on business. The expected big demand for coals from Germany has not materialised, but sales have been effected, though the quantity disposed of for shipment over the next two months or so is reported to be not more than about 100,000 tons, which cannot be considered to be heavy when it is remembered that last year about a quarter of a million tons were shipped direct to German ports, to say nothing of the coals which went from this district for Germany through Dutch and Belgian ports. It is questionable whether the German business, which has been concluded, makes up for the loss of orders from the Continent which have been held up on account of the adverse exchange conditions and the fact that coal prices at the present time are relatively high. The inquiry from Spain is rather more active; that is, for contract supplies. The Norte Railway recently bought 20,000 tons, and now it is reported that the Andalusian Railway wants tenders for 30,000 tons of large and 15,000 tons of small coals; while the Spanish Southern Railways are in the market for 17,000 tons of large and 8000 tons of smalls for delivery from March to December next. The Norwegian State Railways have recently bought 15,000 tons of best Admiralty large double-screened from this district out of a total of 35,000 tons for which firms were asked to quote, shipment having to be made by the end of March. Doubtless the firmness of the coal markets in the North has induced the railways in question to buy rather more than the usual quantity from South Wales.

Working Hours at the Docks.

There has been no improvement in the working conditions at the docks in South Wales, and numerous steamers have had to be kept waiting for loading berths, with consequent loss to shipowners and delay in the clearance of wagons, as a result of which collieries have experienced difficulty in maintaining regular work. In fact, in one case no less than four pits under the control of one undertaking were idle temporarily last week because empties could not be secured; this notwithstanding that there was a plentiful supply of tonnage waiting in dock to take coal from the collieries in question. The loading pressure has been heavy, though the position at the moment is not quite as bad as last week. Congestion means loss of business, as will be seen from the case of a steamer which had been loading steel rails at Cardiff. This steamer was occupied two days in loading the rails, and had to take in 2800 tons of bunkers; but the local brokers were informed that there would be no berth for the steamer for a week, and as a consequence the owners decided to order the vessel round to Glasgow to bunker. So far nothing definite has been done in the matter of revising the hours of work at the docks in order to cope with the delays, but a further stage has been reached. Last week a conference of tippers and trimmers in London discussed the subject and empowered the South Wales representatives to make such changes in working hours as are considered absolutely essential. This rather shows that the workmen's representatives realise that the employing interests have made out a case for some alteration. The men are strongly opposed to the establishment of a complete third shift, but this does not say that they will not agree to an extension of the hours of the existing two shifts. It is understood that they expect to receive extra pay for any concession in working hours; but employers will be opposed to this, as it will have the effect of increasing the costs of the coal and lessen their chances of competing with other coal-exporting districts. However, there is to be a meeting of the joint sub-committee representing the Traders' General Committee, the National Transport Workers' Federation, and the coal trimmers and tippers in the Bristol Channel on Monday next, and hopes are entertained that something will come of the discussion that will help to remove the present delays at the docks. A deputation representing the dock and transport workers had an interview on Tuesday of this week with the Executive Council of the South Wales Miners' Federation for the purpose of finding out how far, if at all, the present conditions and working hours at the docks were responsible for colliery stoppages. The result of their deliberations was a resolution that the Council regretted that although stoppages of collieries had been taking place, the conflict of evidence at its disposal compelled it to refrain from making any pronouncement, believing that the matter was one to be settled by the parties immediately concerned in the negotiations now taking place. It will therefore be seen that the miners' leaders are not prepared to take sides on the question.

Pipe Line Order.

The Cardiff Waterworks Committee on Saturday last reaffirmed the resolution passed by the sub-committee on January 31st accepting the tender of Thomas Piggott and Co., Limited, of Birmingham, for the supply of concrete-lined steel mains for the upper section of the second pipe line from the Taff Fawr watershed. The amount of the tender is £105,911 13s. 10d., and it is a condition that Messrs. Piggott shall have all steel plates for the pipes manufactured at Cardiff, viz., at the Dowlais-Cardiff works belonging to Guest, Keen and Nettlefold, Limited. This will mean the provision of additional employment for steelworkers in this city.

Current Business.

There has been no conspicuous change in the general state of the steam coal market. Irregularity prevails here and there for prompt shipment owing to collieries not being able to secure a regular supply of empty wagons; but in the main the tone is firm and colliery salesmen are not reducing their prices for forward shipment. Best Admiralty large are quoted at 29s. 6d. to 30s., and second qualities are about 29s. Dry coals are better than a week ago, while Monmouthshire descriptions are well sold and firm. The strength of small coals is well maintained, if, indeed, they are not firmer. Best steam smalls are quoted at 22s. to 22s. 6d., and even inferior grades are round about 17s. 6d. to 18s. Coke is higher at 45s. to 50s., but the position of the patent fuel trade is unaltered, and manufacturers' difficulties are as great as ever with the price of pitch at 145s. to 150s. per ton. Anthracite coals are rather quieter for prompt loading, except in the case of cobbles, nuts, beans, duff, and rubbly culm. A certain amount of forward business has been done in anthracite coals, but on the whole the quantity is not very extensive. Pitwood is easier owing to the plentiful supplies and the difficulties of importers to get wagons into which to discharge the wood. Prices are about 24s. to 25s.

Swansea Metal Exchange.

THE tin-plate market is firm, with prices at 21s. to 21s. 6d. basis I.C. f.o.b., but works are not quoting for supplies beyond mid-April, as apart from the increase in the cost of raw materials, the price-fixing scheme terminates under existing arrangements on April 16th. It is understood that the Stabilisation Committee will meet next week, when the question of the renewal of the scheme will be discussed.

Miners Idle.

About 800 men are idle at the Pantyffynon Colliery Company's mines as the result of trouble over the non-unionist and Craftsmen's Union question. The miners insist on the craftsmen giving up their own union and joining the miners' organisation, but the craftsmen are resisting the attempt to smash their union.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding—January Output.

THE Scottish shipbuilding returns for last month are comparatively small, only amounting in all to six vessels of 17,385 tons overall. While these figures are not by any means the lowest recorded, they are well below the average, and a long way behind the returns for the corresponding month last year, which was a record. Of the total for last month, the Clyde is responsible for 15,695 tons, of which the two following vessels form the bulk:—Invergordon, oil tank steamer, 6930 tons, for the British Mexican Petroleum Company, Limited, London; and the Davisian, cargo steamer, 6440 tons, for Frederick Leyland and Co., Limited, Liverpool. New contracts have not been numerous of late, but the number is still being added to. Two steamers of over 8000 tons each have just been contracted for, along with two small cross-Channel cargo and cattle boats.

Steel Company of Scotland—Jubilee.

The Jubilee of the Steel Company of Scotland was celebrated last week. This company was founded in 1873, when the Hallside works were opened, and it is of interest to note that the construction of these works was superintended by Sir William Siemens. The first cast was made in November, 1873, and the first rail was rolled in December of the same year. The early products consisted of tram and railway rails for Glasgow, Liverpool, Manchester, Hull, and Melbourne. A controlling interest in the company has recently been acquired by a number of Clyde shipbuilders, and developments have taken place at the various works owned by the company. An immense new rolling mill has been installed, which will supplant two older mills and yield a larger output of ship plates, estimated at 1500 tons per week.

Steel and Iron.

A brisk business has been done in the steel and iron trades. Consumers have been ordering with more freedom and good orders have been booked on home as well as export account. The steel works are better employed, both in plates and sections, and some are booked for a good time ahead. Steel sheet makers have heavier demands for all gauges. Difficulty is experienced in obtaining sufficient supplies of imported sheet bars and slabs, and home products have to be more extensively utilised, thereby inviting higher costs. Home prices for sheets are now from 5s. to 20s. dearer according to gauge. Malleable iron makers are sharing in the improved demand. General orders are more numerous, and the steel department of the trade is participating. Bar iron is 10s. per ton dearer, and re-rolled steel bars show a similar increase, at about £9 15s. per ton for home delivery. Generally speaking, makers have long been complaining of the unremunerative basis of prices, and the increased demand would have brought higher charges irrespective of the higher costs of raw materials, which they are now faced with as a result of the situation on the Continent. It is hoped that prices may be kept as low as possible, as already it is said that the upward movement threatens to retard the recovery in trade, and again produce that feeling of uncertainty which has so long played havoc with the markets.

Enhanced Coal Prices.

The Scottish coal market has assumed a very strong position, owing chiefly to the activities of German buyers. A considerable turnover has been done in West of Scotland steams, splints and navigation at 26s., 28s., and 30s. respectively, while higher prices have been occasionally mentioned. These prices were named in connection with sales for immediate shipment, and it is said that much firmer rates have been quoted for forward business. The collieries in the Lothians and Fifeshire are also reaping a large share of this business, and great activity is noticeable at the docks at Leith, Grangemouth, Methil and Burntisland. Exporters are finding difficulty in obtaining supplies. Holders are not too keen to sell largely while prices are rising, especially with the collieries already well booked up. Apart from the German demand, good orders have come from Scandinavia and Italy, while French buyers have also shown some activity. Shipments are lower than last week, owing to steamers arriving out of position. Clearances in all amounted to 298,145 tons, against 311,226 in the preceding week, and 319,599 tons in the same week last year. Home demands are of a very quiet nature. Industrial requirements are easily met, and the better qualities of house coal alone show a fair measure of activity.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MAJOR R. A. JONES desires us to say that, after several years military service, he has resumed his practice at Chappell's Chambers, Castle-street, Swansea.

WE are informed that Messrs. A. C. Alexandra and Co., 10 Iddesleigh House, Caxton-street, Westminster, S.W. 1, have been appointed selling agents for Howells motors (1, 2 and 3-phase).

CLEWORTH, WHEAL AND CO., Limited, Castleton, near Manchester, inform us that its new representatives for the London area are Dekteroff, Francke and Reppman, of 118, Queen Victoria-street, London, E.C. 4.

GEORGE NELSON AND CO., Limited, 109, Pilgrim-street, Newcastle-on-Tyne, have been appointed representatives for the Latona Engineering Company, Limited, in the area embracing the Cleveland district of Yorkshire, Northumberland and Durham.

MR. GUY F. DOWDING has resigned the London managership of the Talbot-Stead Tube Company, Limited, which position he has filled for the past four years. He is continuing his engineering business at *Morning Post* Building, Strand, W.C., and also as London sales manager of the Projectile and Engineering Company, Limited, and the Sheffield Twist Drill and Steel Company, Limited.

R. AND W. HAWTHORN, LESLIE AND CO., Limited, Newcastle-upon-Tyne, have opened a new office in Westminster at 3a, Dean's-yard, S.W. 1, telephone No. 2424 Victoria, and telegraphic address "Hawlesco, Parl, London." The office will be under the supervision of Mr. Robert S. Rowell, one of the directors resident in London. The company's city office at Exchange Chambers, 24, St. Mary-axe, will continue as heretofore.

THE STANTON IRONWORKS COMPANY, Limited, near Nottingham, has decided to put three further blast-furnaces into operation on March 1st. The company will then be working twelve out of its seventeen furnaces. It has acquired Mr. Israel's patent for centrifugally lining metal pipes with concrete. There is nothing novel in the cement and concrete lining of metal pipes, but the method devised by Mr. Israel is new, and results, it is claimed, in a superior product.

CALENDARS, DIARIES, &c.

LEA RECORDER COMPANY, Limited, 28, Deansgate, Manchester.—Desk pad, with weekly tear-off sheets. Pages of installations carried out by the company have been inserted.

KRYN AND LAHY METAL WORKS, Limited, Letchworth.—Wall calendar, with monthly tear-off sheets. Each sheet contains a reproduction of some piece of work carried out by the company.

THE BRITISH THOMSON-HOUSTON COMPANY, Limited, Rugby.—Large wall calendar, with monthly tear-off sheets. On each sheet appears an illustration of some important plant installed by the firm.

R. Y. PICKERING AND CO., Limited, Wishaw, Scotland.—Wall calendar, with monthly tear-off sheets. The view of a railway carriage supplied to the Caledonian Railway Company has been reproduced.

CLAY CROSS COMPANY, Clay Cross, near Chesterfield.—Handy little pocket diary. A great mass of useful information has been embodied in this diary, and many views are reproduced of the firm's products.

"SURVEYORS' TABLES AND DIARY." Revised and re-written by a Fellow of the Surveyors' Institution.—This diary is supplied by Messrs. Metchim and Son, of 8, Princes-street, Westminster, S.W. 1, at a charge of 2s. 6d.

BURTON, GRIFFITHS AND CO., Limited, 64-70, Vauxhall Bridge-road, S.W. 1.—Wall calendar, with monthly tear-off sheets. Each sheet carries an illustration of some machine or accessory for which Messrs. Burton, Griffiths are the agents.

CONTRACTS.

STEIN AND ATKINSON, Limited, 47, Victoria-street, S.W. 1, has received an order from the Consett Iron Company, Limited, Consett, Co. Durham, for fourteen Chapman gas producers, complete with Chapman, agitators and mechanical feed. The firm has also received a repeat order from the Steel Company of Scotland, Limited, for four Chapman agitators for the Blochairn Works.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	22/6
(1) Spanish	21/6
(2) N. African	21/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	24/ to 24/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 10 0	—
No. 1 Foundry	5 7 6	—
No. 3 Foundry	5 2 6	—
N.E. COAST—		
Hematite Mixed Nos.	5 5 0	5 5 0
No. 1	5 6 0	5 6 0
Cleveland—		
No. 1	5 10 0	5 10 0
Silicious Iron	5 5 0	5 5 0
No. 3 G.M.B.	5 5 0	5 5 0
No. 4 Foundry	5 0 0	5 0 0
No. 4 Forge	4 15 0	4 15 0
Mottled	4 10 0	4 10 0
White	4 10 0	4 10 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	4 0 0	—
,, ,, Foundry	4 10 0	—
(3) Northampton—		
Foundry No. 3	4 7 6	—
,, Forge	3 17 0	—
(3) Derbyshire—		
No. 3 Foundry	4 10 0 to 4 12 6	
Forge	4 10 0	—
(3) Lincolnshire—		
Basic	5 0 0	—
Foundry	4 10 0 to 5 0 0	
Forge	4 5 0 to 4 10 0	
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 15 0 to 6 2 6	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 0 0	10 10 0
Best ,,	12 0 0	—
N.E. COAST—		
Crown Bars	11 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	13 15 0
S. YORKS.—		
Crown Bars	11 10 0 to 12 0 0	
Best ,,	12 10 0	—
Hoops	14 0 0	—
MIDLANDS—		
Crown Bars	10 15 0 to 11 5 0	
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	10 7 6 to 10 10 0	
Gas Tube Strip	10 15 0 to 11 0 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 0 0	—
Ship Plates ½in. and up	9 0 0	—
Sections	8 15 0	—
Steel Sheets ⅛in. to ½in.	11 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 15 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 10 0	—
Angles	9 0 0	—
Boiler Plates	13 0 0	—
Joists	9 0 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0 to 14 0 0	
Channels	9 5 0	—
Hard Billets	8 15 0	—
Soft Billets	8 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 0 0	—
Light ,,	10 0 0 to 10 10 0	
Billets	9 0 0	—
MANCHESTER—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	9 0 0 to 10 0	
,, (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	9 5 0	—
Intermediate Basic	9 0 0	—
Soft Basic	8 5 0 to 8 10 0	
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	10 0 0 to 10 10 0	
MIDLANDS—		
Small Rolled Bars	9 15 0	—
Billets and Sheet-bars	8 0 0 to 8 5 0	
Gas Tube Strip	10 5 0 to 10 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	18 10 0 to 18 15 0	
Angles	9 10 0 to 9 15 0	
Joists	9 10 0 to 9 15 0	
Tees	10 10 0 to 10 15 0	
Bridge and Tank Plates	9 15 0 to 9 17 6	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	21/- to 21/6
Block Tin (cash)	183 12 6
,, (three months)	185 12 6
Copper (cash)	65 5 0
,, (three months)	65 17 6
Spanish Lead (cash)	28 2 6
,, (three months)	27 12 6
Spelter (cash)	35 2 6
,, (three months)	34 5 0
MANCHESTER—	
Copper, Best Selected Ingots	71 10 0
,, Electrolytic	73 0 0
,, Strong Sheets	98 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 1 0
,, Condenser	0 1 1½
Lead, English	29 10 0
,, Foreign	28 10 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23	10/6
,, 6 p.c. to 8 p.c. ,,	£21 0 0	8/-
,, 8 p.c. to 10 p.c. ,,	£20 0 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£54 0 0	20/-
,, ,, 1 p.c. ,,	£64 0 0	22/6
,, ,, 0·75 p.c. carbon	£72 0 0	25/-
,, carbon free	1/7 per lb.	
Metallic Chromium	4/9 per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£11 2 6 scale 5/- per unit	
,, ,, 75 p.c.	19 10 0 scale 6/- per unit	
,, Vanadium	17/- per lb.	
,, Molybdenum	9/6 per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£130	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	25/-
,, ,, Ell	28/-
,, ,, Splint	26/6 to 29/-
,, ,, Trebles	23/3
,, ,, Doubles	21/9
,, ,, Singles	20/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	23/-
,, ,, Splint	26/6
,, ,, Trebles	23/3
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	24/- to 28/-
Screened Navigation	32/-
Trebles	23/6
Doubles	22/-
Singles	20/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	26/-
Secondary Steam	25/-
Trebles	23/6
Doubles	22/6
Singles	20/6

ENGLAND.

(8) N.W. COAST—	
Steams	29/-
Household	46/3 to 57/6
Coke	36/-
NORTHUMBERLAND—	
Best Steams	27/6 to 28/-
Second Steams	25/- to 26/6
Steam Smalls	17/- to 18/-
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	26/- to 27/-
Second	26/-
Household	25/- to 28/-
Foundry Coke	45/- to 50/-

SHEFFIELD—	INLAND.
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	25/6 to 27/6 —
,, ,, House	23/- to 24/6 —
,, ,, Large Nuts	20/6 to 22/6 —
,, ,, Small ,,	15/- to 16/6 —
Yorkshire Hards	21/- to 22/- —
Derbyshire ,,	20/- to 21/- —
Rough Slacks	9/6 to 11/- —
Nutty ,,	7/9 to 9/9 —
Smalls	3 - to 5/- —
Blast Furnace Coke (inland and Export)	29/- to 30/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	29 6 to 30/-
Second ,, ,,	28/- to 29/-
Best Dry Large	28/- to 28/6
Ordinary Dry Large	26/6 to 27/6
Best Black Vein Large	28/- to 29/-
Western Valley ,,	28/- to 28/6
Best Eastern Valley Large	27/6 to 28/-
Ordinary ,, ,,	27/- to 27/6
Best Steam Smalls	21/6 to 24/-
Ordinary ,,	17/6 to 20/-
Washed Nuts	25/- to 32/6
No. 3 Rhondda Large	29/- to 30/-
,, ,, Smalls	19/- to 21/-
No. 2 ,, Large	26/- to 27/-
,, ,, Through	21/6 to 23/-
,, ,, Smalls	16/- to 17/-
Coke (export)	45/- to 50/-
Patent Fuel	35/- to 37/6
Pitwood (ex ship)	24/- to 25/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	35/- to 37/6
Seconds	30/- to 32/6
Red Vein	29/- to 30/-
Machine-made Cobbles	52/6 to 55/-
Nuts	52/6 to 55/-
Beans	45/- to 47/6
Peas	21/- to 23/-
Breaker Duff	11/- to 12/-
Rubbly Culm	14/- to 14/6
Steam Coals:	
Large	26/- to 27/-
Seconds	23/- to 25/-
Smalls	13/6 to 15/-
Cargo Through	18/- to 22 6

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Higher Prices.

So far as concerns the provision of coal from the Ruhr it would seem that the French are beginning to secure some tangible result from their occupation of that territory, the prohibition of consignments to unoccupied Germany having rendered available for this country considerable supplies of coal that have accumulated at the pits. Whether coke will be obtained with equal facility is another matter. There is a general belief that ample supplies of coke from the Ruhr will be forthcoming in about two weeks' time, but whatever may happen in the immediate future it is certain that the situation at present is a very serious one. In some cases efforts have even been made to prevent the damping down of additional blast-furnaces in Lorraine by importing coke at great cost from Czecho-Slovakia. These attempts are experimental, and are not likely to be repeated. At the moment the basis quotation for coke during the second half of the month in 150 francs per ton for quantities representing from 40 to 50 per cent. of the normal consumption, and 200 francs for additional quantities. It is obvious that these requirements can only be met by imported coke, of which deliveries cannot be guaranteed, so that the situation will remain extremely precarious until it is known whether the coke ovens in the Ruhr can be kept going to supply local and French needs. Events so strongly impressed upon the French the complete dependence of the Lorraine pig iron industry upon German coke, that every possible combination is being investigated for removing what is obviously a very serious danger, and it is evident that whatever arrangements are made with Germany to ensure a withdrawal from the Ruhr, the question of supplying German coke to Lorraine will be given especial prominence. The damping down of so many blast-furnaces and the precariousness of the situation are naturally diminishing iron and steel production and causing a hardening of prices, and consumers find it difficult even to get quotations at all, especially in view of the further complication arising from the rapid depreciation of the franc at a time when so much material has to be purchased abroad. Obviously, the immediate future depends entirely upon the turn events will take in the Ruhr, and until the situation becomes more settled, there is little hope of a recovery in trade activity.

Increased Duties.

The necessity of buying material abroad at a time when the franc has undergone a further heavy depreciation is helping to strengthen the case of manufacturing interests, which insist upon burdening imports of finished goods with heavier duties. The tightening up of the protectionist policy is being strongly opposed by the commercial community, which sees that there can be no great development of foreign trade if further obstacles are placed in the way of imported goods. The passage of a Bill through the Chamber of Deputies for replacing the "accessory taxes" by a fixed tax has awakened a good deal of criticism now that it is seen that this apparently innocuous measure really means a substantial increase in the import duties. At first it was hoped that the 20 centimes per cent. *ad valorem* increase would replace the coefficients; but it is really in addition to them, so that the duties will be increased to this extent less the "accessory taxes," which at present add appreciably to the amount of duty paid. To make matters worse the duty will be imposed on raw materials that are at present imported free. This provision is arousing very strong opposition from consumers, and instances are given of the disastrous effect it will have upon the textile industry, for example, by enormously increasing the cost of cotton. The Government is being urged to modify the Bill in its passage through the Senate, so far as concerns at least raw materials, and it is probable that the whole matter will come up for full discussion, for it was understood that no changes would be made in the existing tariff until the Government had declared its commercial and industrial policy, about which the commercial and manufacturing classes are far from being in agreement.

Engine Nomenclature.

The application of the term "semi-Diesel" to engines in which the fuel is injected by means other than the heat of compressed air has become so general that the Chambre Syndicale de l'Industrie des Moteurs à Gaz has found it necessary to fix upon a standard nomenclature of the different classes of engines, and it has been decided to divide them into two main classes:—(1) External combustion engines, in which the heat is generated outside the organs of mechanical transformation, such as steam engines and hot-air engines; and (2) internal combustion engines, in which there is a direct utilisation of heat, these being divided into two categories: (*a*) explosion engines, in which are included all constant volume combustion engines working on the Carnot cycle, together with heavy oil engines having mechanical fuel injection, and (*b*) progressive combustion engines based upon the principle of combustion at a constant pressure and covering Diesel type engines with pneumatic injection of fuel and without water injection. According to the French terminology hot bulb engines with mechanical injection of fuel are classed as explosion engines, and Diesel engines with air compressors for fuel injection as progressive combustion engines.

Tunnelling.

Several important tunnelling projects are at present under consideration, including no fewer than four, which it is proposed to drive through the Vosges to connect up the French and the Alsatian railway systems. Two of them will permit of the Est line being extended from Saint-Dié to Saales, on the one hand, and to Sainte-Marie-aux-Mines on the other, and have already been approved. Work upon the first tunnel will be started as soon as possible. Plans have also been prepared for driving two tunnels through Mont Blanc at an altitude of 1115 m., and having a length of 14,350 m.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

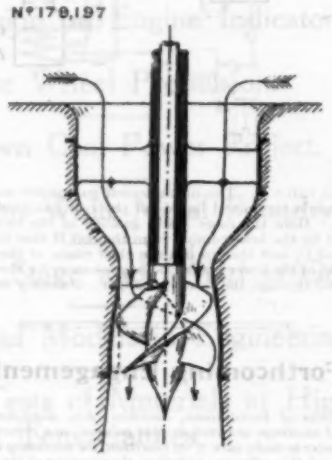
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TURBINE MACHINERY.

179,197. May 1st, 1921.—HIGH SPECIFIC SPEED WATER TURBINES, Actiengesellschaft der Maschinenfabrick von Theodor Bell et Cie., Kriens, near Luzern, Switzerland.

THIS specification is somewhat involved, but the chief claim reads as follows:—"A high specific speed water turbine in which guide vanes are provided and the rotor wheel works in a chamber, the water flowing through the wheel in a substantially axial direction, said rotor wheel having no outer rim and being provided with at the utmost three blades shaped according to a screw of helicoidal surface having a varying axial pitch, the length of the blades being so chosen that for any point of the blade the length of the line of intersection of the blade with a streamline surface passing through this point is greater than the circumferential pitch of the blades in this streamline surface at the discharge end of the rotor wheel." In explanation of the

N° 179,197



use of a varying pitch it is stated that "the application of a true helicoidal shape for the rotor wheel blades would not be advantageous to a gradual transmission of energy from the water to the rotor wheel and the blades are therefore designed as helicoidal surfaces having a variable axial pitch. It is favourable to use a pitch that decreases by degrees when seen in the direction of the relative flow of the water, *i.e.*, the angle at the entrance of the blades being greater than the angle at the discharge end. The increase of the entrance angle presents the advantage that a decrease of the high relative speed at the entrance end of the rotor wheel and an increase of the speed of the axial flow of the water through the rotor wheel is attained, whereby the diameter at the entrance end of the rotor wheel is reduced and a higher specific speed is attained."—*January 4th* 1923.

TELEGRAPHS AND TELEPHONES.

166,560. July 19th, 1921.—IMPROVED MEANS FOR THE PRODUCTION OF ELECTRICAL OSCILLATIONS BY MEANS OF CHOKE COILS OF TRANSFORMERS WITH AUXILIARY MAGNETISATION, Gesellschaft für Drahtlose Telegraphie, M.B.H., 9, Tempelhofer Ufer, Berlin, Germany.

In the diagram, A is a high-frequency machine which delivers alternating current to choke coils B wound upon separate iron cores as shown, and these coils are connected to the antenna or output circuit C. Across the middle points of the choke coils there is a condenser D, and its capacity is such that the resistance

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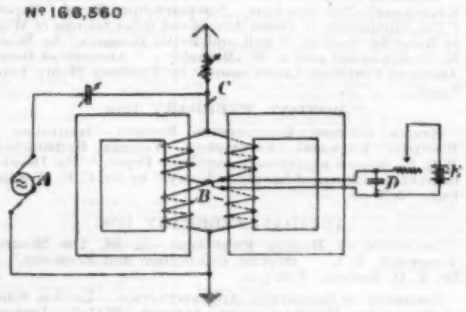

it offers to any of the harmonics of the fundamental is negligible. Direct current is supplied to the windings from a battery E. With this arrangement any frequencies which can result from doubling the fundamental frequency or, indeed, any frequency present in the primary circuit can be removed so that only odd harmonics will be present in the output circuit, and by tuning the latter the desired harmonic can be caused to persist.—*December 19th*, 1922.

190,736. June 23rd, 1921.—IMPROVEMENTS IN AND RELATING TO ELECTRIC SIGNALLING OVER SUBMARINE CABLES, Benjamin Davis and the Eastern Telegraph Company, Limited, of Electric House, Finsbury-pavement, E.C. 2.

This specification describes a method of diminishing the attenuation constant of submarine cables. The invention consists of introducing electromagnetic loads into an otherwise plain cable. The short core A consists of fine iron wire, which is twisted so as to form either a positive or negative angle such as at B. The core is embraced by a magnetising strip C, which is laid on at an angle D with regard to the axis of the core A. The tape forms a continuation of the copper conductor of the cable and may be of any convenient cross section. The cross section of the iron core and the angle of the copper tape winding

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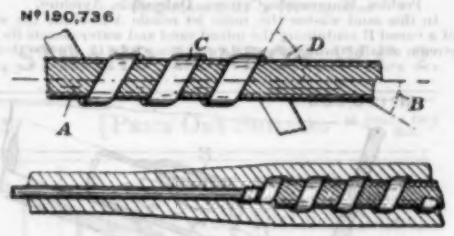

are adjusted so as to produce the required inductance.—*December 27th*, 1922.

176,381. March 5th, 1922.—IMPROVEMENTS IN RADIO ANTENNA SYSTEMS, Gesellschaft für Drahtlose Telegraphie, M.B.H., 9, Tempelhofer Ufer, Berlin, Germany.

This invention relates to antenna systems in which insulated earth lines are provided with the object of reducing the balancing currents through the earth. In the diagram A is the antenna

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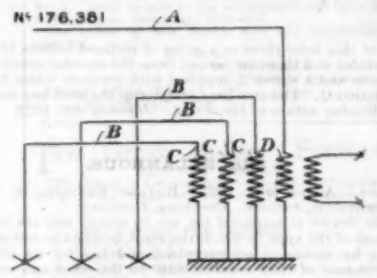

while B B B are the earth lines. In each of these lines there is a winding C which are coupled to a winding D in the vertical lead to the antenna, the windings C producing currents in the lines B which balance the currents induced in the lines by the antenna.—*January 4th*, 1923.

TRANSFORMERS AND CONVERTERS.

190,934. February 1st, 1922.—IMPROVEMENTS IN OR RELATING TO TRANSFORMERS, The English Electric Company, John Whitheley Howard and Jocelyn Arthur St. Clair Richardson, all of Queen's House, 28, Kingsway, W.C. 2.

Between each primary and secondary winding of the core type transformer described in this specification there are twelve packets A of magnetic shunting material with small intervening

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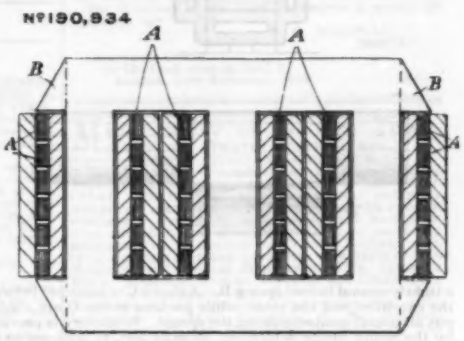

air gaps, and the invention consists in providing the magnetic extensions B to the yokes to produce symmetrical leakage conditions for all the phases and the reactance values of all the phases are made equal.—*January 14th*, 1923.

AERONAUTICS.

190,800. September 28th, 1921.—AEROPLANE WINGS, A. P. Thurston, 29, Southampton-buildings, Chancery-lane, London, W.C. 2, and the Bristol Aeroplane Company, Limited, Filton House, Bristol.

The outer end of an aeroplane wing is, according to this specification, formed as a series of small pinions, each of which is of aerofoil form, that are spaced apart some distance in the

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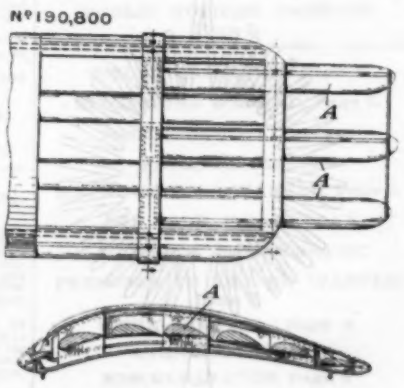
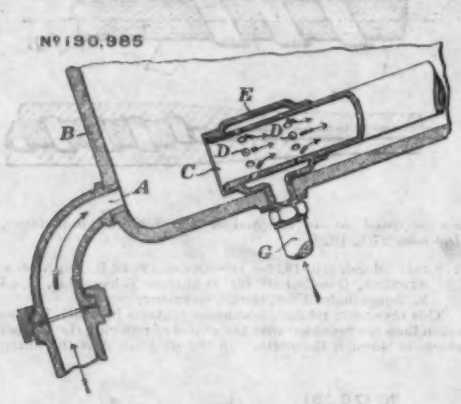


fore and aft direction. Between them there is a second set of pinions A A, which may be extended as shown in the drawing, or retracted so as to form a more or less complete wing surface.—*December 28th*, 1922.

WATER PURIFICATION.

190,985. September 15th, 1922.—SAND-WASHING APPARATUS, Glenfield and Kennedy, Limited, Kilmarnock, and J. Peebles, Waterworks Cottage, Dalrymple, Ayrshire.

In this sand washer the main jet nozzle A fixed in the wall of a vessel B containing the mixed sand and water directs its jet stream axially through a usual combining tube C. In the throat

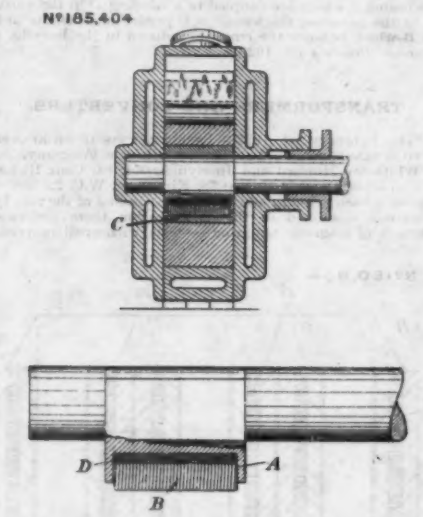


part of this tube there is a series of inclined orifices D forming jet nozzles and these are served from the annular space between the tube and a sleeve E supplied with pressure water by a pipe connection G. The auxiliary jets stir up the sand and accelerates the cleaning action of the water.—*January 4th*, 1923.

MISCELLANEOUS.

185,404. August 9th, 1922.—ROTARY ENGINES, M. Güttner, Schmölln, Sachsen, Altenburg, Germany.

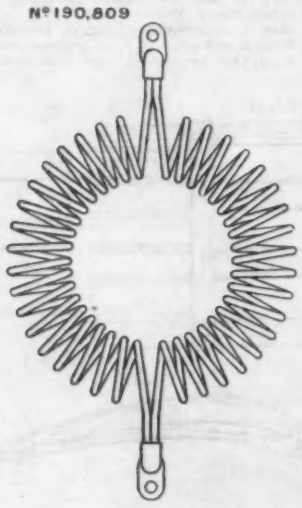
This device is intended for use in rotary engines and compressors of the type in which the rotor is rolled round inside the casing by means of an excentric, and has for its object the maintenance of close contact between the rotor and casing. A rectangular groove A is cut in the excentric, and into this is fitted



a tightly wound helical spring B. A sleeve C is arranged between the excentric and the rotor, while packing strips D are used to put an initial compression on the spring. Resiliency is provided by the round spring deforming, more or less, to conform to the rectangular groove. The spring cannot move otherwise.—*December 28th*, 1922.

190,809. September 29th, 1921.—IMPROVEMENTS IN AND RELATING TO ELECTRIC REACTORS, The British Thomson-Houston Company, Limited, of 83, Cannon-street, E.C. 4, and Henry Stanley Holbrook, of 34, Lancaster-road, Rugby.

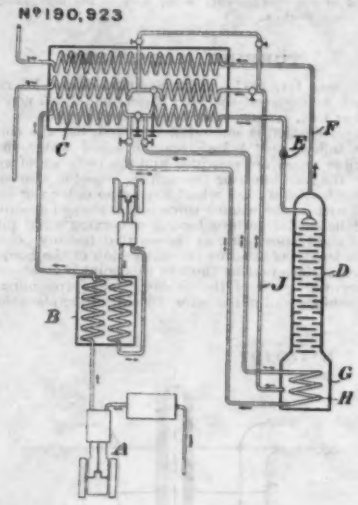
This invention consists in arranging the windings of a reactor so that the terminals are at the maximum distance apart, and also in sectionalising the winding and interconnecting the sections so that eddy currents are greatly reduced. A high voltage



reactor made in accordance with one of the schemes described in the specification is shown. The direction of the windings is such that the two parts assist each other in the production of a magnetic field around the ring. There are five other illustrations.—*June 4th*, 1923.

190,923. January 9th, 1922.—APPARATUS FOR THE SEPARATION OF GASEOUS MIXTURES, *E. C. R. Marks*, 57, *Lincoln's Inn-fields, London*.

This specification covers an improvement in the processes used for the production of very low temperatures and the separation of gases by means of those temperatures. The mixture of gases is compressed by the machine A and cooled by the pre-cooler B, after which it is delivered to the coil C of the heat exchanger. The gases flow on to the rectifying column D, into which they are discharged after passing through the



expansion valve E. The unpondensed gas passes away by the pipe F, while the mixed liquids of the two gases collect in the kettle G. Here the more easily gasified of the two liquids is boiled off by the heat coming from the coil H that forms a part of the coil C, and therein lies the chief claim of the invention. The liquid of the lower boiling point goes away by the pipe J and also passes through the heat exchanger.—*January 4th*, 1922.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, S.W. 1. Adjourned discussion on symposium of papers on "Indicators." 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecture, "The Effect of Temperature on the Properties of Engineering Materials," by Professor F. C. Lea. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse: "Rothamsted and Agricultural Science," by Sir John Russell. 9 p.m.

WEST BROMWICH ENGINEERING SOCIETY.—Technical School, West Bromwich. Paper: "Wireless Telephony," by Mr. H. Littley. 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—The City Art Gallery, Mosley-street, Manchester. Conversazione. 7.30 p.m.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science, South Kensington, S.W. 7. Annual general meeting. 5 p.m.

INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Royal Victoria Station Hotel, Sheffield. Paper, "Aerial Ropeways," by Mr. S. E. Fedden. 7 p.m.

SATURDAY, FEBRUARY 10TH.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the Greenford factory of J. Lyons and Co., Limited.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—The Institute, Newcastle-upon-Tyne. Papers: "The Elimination of Power Losses and other Sources of Waste in Mines by the Use of Ball and Roller Bearings," by Messrs. K. C. Appleyard and A. W. Macaulay; "Abstract of Recent American Coal-dust Experiments," by Professor Henry Louis. 2 p.m.

MONDAY, FEBRUARY 12TH.

KING'S COLLEGE ENGINEERING SOCIETY.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Second anniversary meeting. Paper, "The Development of the Electrical Supply Industry," by Mr. C. H. Wordingham. 5.30 p.m.

TUESDAY, FEBRUARY 13TH.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower-hill, E. 1. "Internal Combustion and Economy," by Mr. T. D. Madsen. 6.30 p.m.

INSTITUTE OF INDUSTRIAL ADMINISTRATION.—London School of Economics, Houghton-street, Aldwych, W.C. 2. Lecture: "Practical Hints on Buying and Selling," by Mr. F. Mott. 8 p.m.

INSTITUTE OF TRANSPORT.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Metropolitan Graduate and Student Society Meeting. Paper: "Railway Rules and Regulations," by Mr. B. Wagenrieder. 6 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper, "Some Practical Notes on Oil Pumping," by Mr. G. W. E. Gibson. 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—207, Bath-street, Glasgow. Paper, "Some Problems in High-speed Alternators and their Solution," by Mr. J. Rosen. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS: NORTH-EASTERN SECTION.—Armstrong College, Newcastle-upon-Tyne. Paper, "Notes on Shop Management," by Mr. L. C. Edmondson. 7.15 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Continued discussion on "Wind-Pressures, and Stresses caused by the Wind on Bridges." 6 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. Presidential address by Sir T. R. Ratcliffe-Ellis. Paper, "Further Notes on Machine Mining in a Thin Seam," by Mr. H. O. Dixon. 3 p.m.

WEDNESDAY, FEBRUARY 14TH.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. 4. Paper, "Hydraulic and Electric Lifts," by Mr. C. H. J. Day. 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS: LANCASHIRE AND CHESHIRE BRANCH.—Engineering Laboratory, Victoria University, Coupland-street, Manchester. Discussion on Mr. A. S. Spencer's paper: "An Investigation on the Theory of Flexural Resistance." 7.15 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—Armstrong College, Newcastle-upon-Tyne. Discussion 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "The Durability of Refractories," by Mr. W. J. Rees. 8 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Paper, "High-speed Oil Engines," by Mr. J. L. Chaloner. 7.45 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Paper, "The Production, Enrichment and Purification of Water Gas," by Mr. J. G. Kimber. 6 p.m.

ELECTRO-HARMONIC SOCIETY.—Caxton Hall, Westminster, S.W. 1. Concert. 8 p.m.

THURSDAY, FEBRUARY 15TH.

ROYAL AERONAUTICAL SOCIETY.—Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Practical Aspects of the Seaplane," by Wing-Commander T. R. Cave-Brown-Cave. 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Paper, "Some Problems in High-speed Alternators and their Solution," by Mr. J. Rosen. 6 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—28, Victoria-street, S.W. 1. London Graduates' meeting. Paper, "Tractors," by Mr. E. L. Every. 8 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Conversazione at the City and Guilds Engineering College, South Kensington. 9 o'clock.

FRIDAY, FEBRUARY 16TH.

INSTITUTION OF ENGINEERING INSPECTION.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper, "Chemical Inspection as it Is and as it Should Be," by Mr. H. T. F. Rhodes. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette: "Notes on Some Insulating Materials," by Mr. T. L. Allison. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, S.W. 1. Annual general meeting. "Some Mechanical Problems in the Rubber Industry," by Mr. H. C. Young. 6 p.m.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—University College, Singleton Park, Swansea. Paper, "Research and Industry," by Mr. F. C. A. H. Lantsberry. 7.15 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "Muscular Exercise," by Professor A. V. Hill. 9 p.m.

SATURDAY, FEBRUARY 17TH.

WEST YORKSHIRE METALLURGICAL SOCIETY.—Technical College, Bradford. "Cast Iron," by Mr. E. Adamson. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the buildings in course of construction at Wembley for the British Empire Exhibition. 2 p.m.

MONDAY, FEBRUARY 19TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, Glasgow. Paper, "High-speed Oil Engines," by Mr. J. L. Chaloner. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The College, Loughborough. Loughborough Graduates' meeting. Paper, "The Process of Ignition," by Mr. A. P. Young. 7 p.m.

TUESDAY, FEBRUARY 20TH.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND CENTRE.—The Metropole, King-street, Leeds. Paper: "Some Problems in High-speed Alternators and their Solution," by Mr. J. Rosen. 7 p.m.

INSTITUTE OF TRANSPORT.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Graduates' and Students' lecture: "Modernisation of Passenger Railway Stations," by Messrs. F. Bushrod and J. F. S. Tyler. 5.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Meeting of the Coventry Graduates. Paper, "Motor Frames," by Mr. B. W. Dawkins. 7.45 p.m.

WEDNESDAY, FEBRUARY 21ST.

INSTITUTION OF AUTOMOBILE ENGINEERS: WOLVERHAMPTON CENTRE.—Star and Garter Hotel, Wolverhampton. Paper, "The Technique of Calculation," by Mr. James Watt. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Chamber of Commerce, New-street, Birmingham. Birmingham Graduates' meeting. Paper, "Springing Systems for Cars," by Mr. E. N. Salmon. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Informal meeting. 7.30 p.m.

UNIVERSITY OF LONDON.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. "The Control of the Speed and Power Factor of Induction Motors." Lecture I., "Characteristics of the Induction Motor, &c.," by Professor Miles Walker. 5.15 p.m.

THURSDAY, FEBRUARY 22ND.

INSTITUTION OF STRUCTURAL ENGINEERS.—Denison House, 296, Vauxhall Bridge-road, S.W. 1. Paper: "Shear Resistance," by Mr. E. Godfrey; will be read by Mr. H. K. Dyson. 7.30 p.m.

FRIDAY, FEBRUARY 23RD.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette, "Characteristics, Operation and Maintenance of Underground Cables," by Mr. A. J. Tracey. 7.30 p.m.

MONDAY, FEBRUARY 26TH.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' SECTION, LONDON.—Storey's-gate, S.W. 1. Annual lecture, "Photo-elastimetric Researches on Mechanical Engineering Problems," by Professor E. G. Coker. 7 p.m.

TUESDAY, FEBRUARY 27TH.

INSTITUTE OF MARINE ENGINEERS, 85–88, The Minories, Tower Hill, E. 1. "Auxiliary Machinery," by Engineer-Commander R. Beeman. 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Philosophical Hall, Leeds. Lecture, "Engineering Factory Organisation," by Sir Henry Fowler. 7.30 p.m.